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UNIVERSITY OF EDINBURGH / NHS (SCOTLAND)  
TRAINING PROGRAMME**



Socio-emotional behaviour following acquired brain injury

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## **Dedication**

I lovingly dedicate my thesis to my wonderful Kyle who has given me support and encouragement every step of the way. All my love xx

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# 1. Abstract

**Introduction:** Socio-emotional behaviour difficulties following acquired brain injury (ABI) have been shown to have a persisting negative effect on quality of life. A systematic review was carried out to look at the efficacy and clinical effectiveness of available psychological treatments for socio-emotional behaviour difficulties following ABI. Research was carried out to further understand socio-emotional behaviour by exploring the possible underlying cognitive aspects (specifically social cognition) in a traumatic brain injury (TBI) population. The study investigated the relationship between social cognition and socio-emotional behaviour post-TBI.

**Method:** A systematic search of articles published between January 2008 and November 2013 was carried out following the Cochrane (2008) guidelines. Papers were quality assessed to identify strengths and weaknesses. In the research study, forty TBI participants were asked to complete tasks of emotion recognition, theory of mind, cognitive flexibility, processing speed, attention and working memory. Self-rated and proxy-rated behaviour questionnaires were also administered.

**Results:** The systematic review revealed seven studies for inclusion; three papers looked at a Comprehensive Holistic Approach, two papers on Cognitive Behavioural Therapy, and two on Cognitive Rehabilitation Therapy. The findings suggested that CHA showed the best efficacy and generalization. However, there were also positive results within the CBT studies.

The research paper found that the TBI group performed significantly poorer than the control group on measures of emotion recognition and three out of the four ToM



tasks. The TBI group also performed significantly poorer on measures of processing speed and working memory (executive function). There was no association found between performance on any of the cognitive tests and socio-emotional behaviour.

**Conclusions:** This is an area of limited research, likely due to the challenges of carrying out research in an ABI population. The systematic review highlighted the limited research available which has implications in clinical practice due to a lack of evidence base for potentially effective interventions. The research study results suggest that there is still a lack of understanding of socio-emotional behaviour and its underlying cognitive functioning. Further research would improve understanding and could also focus appropriate post-ABI interventions for socio-emotional behaviour problems.

## **2. Systematic Literature Review: Interventions for socio-emotional behaviour difficulties following acquired brain injury**

### **2.1 ABSTRACT**

**Objective:** To review the efficacy and clinical effectiveness of treatments available for socio-emotional behaviour difficulties following acquired brain injury (ABI). This review is an update of Cattelani and colleagues review (2010). Treatment types included Cognitive Behavioural Therapy (CBT), Comprehensive-Holistic Approach (CHA), Cognitive Rehabilitation Therapy (CRT), and Applied Behavioural Analysis (ABA).

**Method:** A systematic search of articles published between January 2008 and November 2013 was carried out using PubMed, Medline, EMBASE, and PsycINFO.

**Results:** Seven studies were appropriate for inclusion; three CHA, two CBT, and two CRT. The findings suggested that CHA showed the best efficacy and generalization. However, there were also positive results within the CBT studies. Results were limited due to the number of papers published and due to limitations within methodology.

**Discussion:** CHA is the SIGN recommended treatment for socio-emotional behaviour difficulties following ABI. The results of this review support these

recommendations. However, findings suggest that there might be other effective interventions that need further research.

**Keywords:** socio-emotional behaviour, Acquired brain injury, Psychological Therapy, Systematic review

(Abstract: 170 words; Main report: 5014 words)

## **2.2 INTRODUCTION**

### ***2.2.1 The effects of an acquired brain injury***

Acquired brain injury (ABI) refers to brain damage that has occurred post-birth and is not due to genetic, congenital, developmental or neurodegenerative disorders. It includes open and closed traumatic brain injury (TBI), central nervous system infections (e.g. meningitis), cerebro-vascular incident, hypoxic injury, disease (e.g. brain tumour) or medical intervention (e.g. radiation) (Lezak, Howieson, Loring, 2004).

Many individuals with these pathologies can exhibit changes in cognition, mood and socio-emotional behaviour (Adolphs, 2003). Socio-emotional behaviour difficulties refer to problems with emotion regulation, social judgement and communication, and performing impulsive acts (Kendall & Terry, 1996; Milders *et al.*, 2008). These are some of more debilitating sequel. It is not only the cause of the brain injury that influences the outcome, other factors such as the area of damage, injury severity, premorbid functioning, and treatment variables also plays a part (Lezak, Howieson & Loring, 2004).

It can be expected that there will be a period of natural recovery of functioning following ABI, where most of the recovery taking place will occur over the first year post-injury (Walker & Jablon, 1961). However, despite some degree of spontaneous recovery, there often remain difficulties that affect socio-emotional behaviour adjustment and community integration (Milders, Fuchs & Crawford, 2003). These

socio-emotional behaviour changes have been found to persist over time, meaning that the socio-emotional behaviour consequences are still present many years post injury (Koskinen, 1998). These changes often have a negative effect on patient rehabilitation, potentially limiting social integration (Oddy *et al.*, 1985), vocational outcome (Lezak & O'Brien, 1988) and previously established relationships (Parente *et al.*, 1990). As a result, this population frequently obtain poorer scores on quality of life measures (Dahlberg *et al.*, 2006) and can experience social isolation (Demakis *et al.*, 2007). They are also at a higher risk of suffering from depression, which can further limit their ability to reintegrate into the community (Gomez-Hernandez *et al.*, 1997). Moreover, family members express a higher level of perceived burden due to behavioural changes when compared with physical or cognitive changes (Oddy & Humphrey, 1980; Brooks *et al.*, 1986).

### **2.2.2 Frontal lobe function**

To identify appropriate interventions for socio-emotional behaviour difficulties in an ABI population, it is helpful to understand the underlying cognitive impairments contributing to such functional alterations. The frontal lobes play a vital role in social cognition and behaviour (Lezak, Howieson & Loring, 2004). However, there is debate over the exact nature of the proposed interactions between underlying cognitive abilities, and one's capacity to understand and appreciate social rules and appropriately monitor and adjust behaviour according to social context (by utilising feedback from social cues) or maintain control of their behaviour and emotional responses (Blair & Cipolotti, 2000; Alvarez and Emory, 2006; Graftman, 2007). Most research into identifying the function of the frontal lobes has focused on

patients with localized brain damage. Some researchers have identified three distinct areas within the prefrontal cortex (ventromedial, dorsolateral and orbitofrontal) that have been shown to be involved in behaviour, emotion regulation and social function.

#### *The ventromedial prefrontal cortex*

The ventromedial prefrontal cortex (VMPFC) is mainly involved in motivation and initiation. Studies of emotion recognition have shown that patients with VMPFC lesions can be impaired in their responses to emotional stimuli and in their ability to understand the emotional states of others in comparison to patients with lesions in other areas of the brain (e.g. Hornak, Rolls, & Wade, 1996). Stone *et al.* (1998) found that patients with dorsolateral prefrontal cortex (DLPFC) lesions performed well on a test of social cognition, but patients with VMPFC lesions made significantly more errors. This supports the theory that VMPFC is involved in making social inferences. Neuroimaging studies also highlight activation of the VMPFC whilst carrying out theory of mind tasks (e.g. Baron-Cohen *et al.*, 1994; Gallagher *et al.*, 2000). Other studies have shown that damage to this area can show a reduction in social interaction (Sbordone, 2000).

#### *The dorsolateral prefrontal cortex*

The DLPFC has been shown to have an important role in the temporal organization of behaviour (Fuster, 1989). This is vital for the voluntary sequencing of actions related to verbal fluency and using strategies (Milner & Petrides, 1984). Studies have shown that localized brain injury in the DLPFC can result in problems with planning,

difficulty initiating ideas and strategies, increased apathy and perseveration, and a reduction in cognitive flexibility and verbal fluency (Blumer & Benson, 1975).

#### *The orbitofrontal prefrontal cortex*

The orbitofrontal prefrontal cortex (OFPFC) is involved in prioritizing stimuli needed for achieving a current goal; by filtering incoming sensory information (Malloy *et al.*, 1993). Damage to the OFPFC can result in problems with insight, antisocial behaviour, distractibility, reasoning and disinhibited behaviour, an inability to suppress automatic responses and personality change (Blumer & Benson, 1975).

#### **2.2.3 Socio-emotional behaviour interventions**

Despite the high level of socio-emotional behaviour difficulties following an ABI, until very recently, standardised social behavioural rehabilitation had not been developed. However, social skills based rehabilitation is often introduced; this being supplementary to other cognitive rehabilitation approaches (e.g. attention, language and memory), which themselves have a strong and developing evidence base (Cicerone *et al.*, 2000; Cappa *et al.*, 2005).

There has been extensive research into the efficacy of social skills interventions for other populations. Trower (1978) identifies using training social skills, consolidation and generalizing in the development of new social skills. There are also multiple studies looking at social skill development in a range of populations, also concluding that new social skills can be taught, demonstrate some degree of generalization, and improve overall social functioning (Bellack *et al.*, 2004). The research into the

underlying neuropsychological causes and the effectiveness of intervention for socio-emotional behaviour difficulties in an ABI population is far more limited (Cattelani, Zettin & Zoccolotti, 2010).

In 2013 the Scottish Intercollegiate Guidelines Network (SIGN) ‘Brain injury rehabilitation for adults’ guidelines recommended a comprehensive-holistic neuropsychological rehabilitation programme to focus on emotional, behavioural and cognitive difficulties affecting individual functioning in a post-acute setting (along with standard cognitive rehabilitation). Although it is recommended that the goal focus is on improving functioning, there is no specific prescribed approach for socio-emotional behaviour intervention. There are specific cognitive rehabilitation recommendations for improving executive functioning including problem solving strategies, goal management strategies and logical reasoning. However, there are no recommendations for improving emotional processing or self-monitoring due to lack of evidence and there is no mention of other underlying social skills that are vital to effective socio-emotional functioning (e.g. theory of mind skills or social rules/boundaries). Therefore, it is clear that more research is needed in this area to identify an effective evidence-based intervention for the treatment of socio-emotional behaviour difficulties in an ABI population.

#### ***2.2.4 The current evidence base***

Cattelani, Zettin and Zoccolotti (2010) carried out a review (including 63 research papers) to examine the efficacy and effectiveness of interventions based on applied behavioural analysis, cognitive therapy and comprehensive-holistic approaches in the



treatment of behavioural disorders following acquired brain injury. Key findings reported greatest improvement in socio-emotional behaviour following a Comprehensive-Holistic intervention. Consequently, it was recommended that this should be the treatment standard for adults following an ABI. However, they also found that both Cognitive Behavioural Therapy and Applied Behavioural Analysis approaches were evidence-based treatments. This review will complement Cattelani, Zettin and Zoccolotti (2010) review. This paper will extend this examination by updating the search from 2008 to November 2013. It is important that there is an up to date review of this literature as the SIGN guidelines have recently been updated in 2013 recommending the use of a Comprehensive-Holistic intervention for socio-emotional impairment but this is based on limited evidence.

For the purpose of the current review, the existing interventions for individuals with social and behavioural disorders following ABI were placed in one of three approach categories; placement depending upon their intervention characteristics. The three categories used by Cattelani, Zettin and Zoccolotti included, (1) Applied Behavioural Analysis, (2) Cognitive-Behavioural Therapy, and (3) Comprehensive-holistic Approaches.

### *1. Applied Behavioural Analysis (ABA)*

This approach looks at manipulating the antecedents and/or consequences of behaviour to manage or manipulate specific maladaptive behaviours (Cattelani, Zettin & Zoccolotti, 2010). Learning theory, including respondent and operant conditioning, underlies the two main approaches. The first approach focuses on

changing the frequency, duration and intensity of a particular behaviour by modifying the consequence of the behaviour through positive or negative reinforcement (e.g. token-economies, time-out, verbal praise or response-cost procedures). The second approach focuses on the manipulation of the antecedent and aims to reduce the maladaptive behaviour by facilitating a positive behaviour. This is done through the combination of enabling the individual to self-manage the situation through skill acquisition (e.g. fading, feedback, shaping, redirection, prompting) in combination with modeling (Ducharme, 2000; Carr *et al.*, 2002).

The antecedents, behaviours and consequences are unique to each individual and so a person-centred and problem-focused approach is used to affect change. It is usually aimed at only one or two maladaptive behaviours at one time and so it is usually time-limited. Applied behavioural analysis can stand alone as an intervention to change behaviour, or it has been used as the first step in therapy prior to, or in conjunction with, other interventions. This is due to difficulties engaging in other types of therapy due to agitated, non-compliant or disruptive behaviour (Ducharme, 1999).

## *2. Cognitive Behavioural Therapy (CBT)*

This approach is based on the assumption that cognitions, emotions and behaviours are interlinked (Chittum *et al.*, 1996). CBT uses the therapeutic relationship as an active part of therapy along with using behavioural techniques, such as reinforcing alternatives to maladaptive behaviours. The other therapeutic techniques used includes identifying and changing dysfunctional behaviours and thought patterns,

learning and using effective coping strategies to reduce stress levels, learning relapse-prevention strategies, and learning acceptance related to changes from premorbid functioning (Giles & Manchester, 2006). In this review, the papers included have a behavioural orientation even though the focus of the therapy is on the internal emotional difficulties that lead to socio-emotional behaviour difficulties.

### *3. Comprehensive-Holistic Approaches (CHA)*

This approach is based on the theory that difficulties in neuropsychological and/or psychological factors are underlying maladaptive socio-emotional functioning (Cattelani, Zettin, & Zoccolotti, 2010). The aim of the intervention is to encourage the individual to develop adaptive skills, compensatory behaviours or strategies rather than directly attempting to rehabilitate dysfunctional cognitive processes, resulting in the individual learning to self-manage difficult situations without external support (Cattelani, Zettin, & Zoccolotti, 2010). This approach is more likely to have effects that generalize to everyday situations due to this new skill acquisition. The individual and group sessions are usually focused on cognitive, behavioural, socio-emotional factors. The therapeutic alliance also plays a major role in the therapy, which is important when focusing on improving the level of insight, realism and acceptance of any brain injury related impairments (Christensen & Uzzel, 1994; Klonoff, 1997).

The current review included the CBT and CHA approaches. However, research of the ABA approach is often limited to individuals with a more severe ABI and those that are in an inpatient setting. The approach is also vastly different in nature to the

other two therapies, which involve the patient's active engagement in the process. For these reasons, a systematic review including the ABA approach would provide limited evidence due to the quality criteria being unable to account for both types of intervention. This may have been a factor in the Cattelani, Zettin and Zoccolotti (2010) review, which limits the interpretation of the evidence found for the ABA approach. For this reason, the current review excluded the ABA approach. However, from reviewing the available literature it was decided that an additional category of (4) Cognitive Rehabilitation Therapy would also be included.

#### *4. Cognitive Rehabilitation Therapy (CRT)*

This approach is based on the relearning of, or compensating for, lost or damaged cognitive skills that have a negative impact on socio-emotional functioning. The therapy incorporates psycho-education on cognitive components to help identify and raise awareness of strengths and weaknesses. It then focuses on the training of skills that have been lost through brain damage. If this is not possible then training moves to internal and external/environmental compensatory strategies. The aim is to improve the individual's socio-emotional functioning by focusing on the underlying neuropsychological deficits.

The present review will focus on the efficacy and clinical effectiveness of each of the three treatments (CBA, CHA, and CRT), as applied to adults with socio-emotional behaviour difficulties following ABI. The review will look at the overall efficacy and effectiveness of all three psychological treatments before looking at the differences between interventions.

## **2.3 METHOD**

### ***2.3.1 Literature search strategy***

A literature search was carried out using four electronic databases: Medline [January 2008-November 2013], PsycINFO [2008-November 2013], CINAHL [2008-November 2013], and EMBASE [2008-November 2013]. The start date was selected as this search was intended to look at recent data that was not included in the systematic review by Cattelani, Zettin and Zoccolotti (2010). The search also included verifying that no other similar reviews had been carried out. The search terms used related to a population that had an ‘acquired brain injury’ (ABI) and were combined using ‘AND’ with terms linked to ‘social’ ‘OR’ ‘behavioural problems’. Each key word inclusion was checked for each database to ensure all the areas of focus were included (for example, EMBASE terms included ‘mental disease’, ‘behavioural disorder’, ‘emotional disorder’, ‘antisocial personality disorder’, ‘social problem’, ‘brain injury’, ‘aggression’, ‘depression’ and ‘personality disorder’). Searches were confined to the domains of title, abstract and keywords. Searches were also carried out in reference lists of all articles that were eligible, as well as a search for citations of each of these articles.

### ***2.3.2 Eligibility criteria***

Studies were included if: 1) articles were published in the English language and in a peer reviewed journal; 2) papers included individuals with ABI who were between the age of 18 and 65 years; 3) the primary research aim was to evaluate a socio-emotional behaviour therapy using quantifiable measures.

### **2.3.3 Exclusion criteria**

Studies were excluded if: (1) they did not use quantitative data, using only descriptive reports or having a theoretical focus; (2) they had an epidemiological focus, pharmacological interventions or alternative medicine (e.g. music or art therapy); (3) the interventions were based exclusively on specific task training, occupational therapy, or vocational rehabilitation; (4) it was included in the review by Cattelani and colleagues (2010); (5) it was based on an ABA therapy; (6) case studies.

**Table 1. Summary of literature sources and resultant review articles**

Article Source	Number of relevant articles initially screened for potential inclusion	Number of articles included within this review	Review article number*
PsycINFO	45	2	2, 5
EMBASE	95	1	6
Medline	36	1	7
CINAHL	37	3	3, 4, 1
All sources (total)	213	7	1-7

\*Review article numbers denote the following articles 1. McDonald *et al.* (2008); 2. Miotto *et al.* (2009); 3. Fong & Howie (2009); 4. Walker *et al.* (2010); 5. Braden *et al.* (2010); 6. Hart *et al.* (2012); 7. Aboulafia-Brakha *et al.* (2013)

#### ***2.3.4 Data collection and management process***

The literature search process is detailed in Figure 1. The initial search, using the previously mentioned search strategy, produced 1551 articles (314 from PsycINFO, 96 from Medline, 651 from EMBASE and 490 from CINAHL). Refworks reference management software was used to remove all duplicates and then the titles and abstracts of these articles were screened. This excluded 1523 papers, leaving 28 papers to review in more detail. A further 21 papers did not meet inclusion criteria so the remaining seven articles were included in this review. The references of these seven papers were also searched for possible articles that were not included in the original database search. None were identified as potential papers for inclusion; therefore, seven papers were included in this systematic review. This is summarized in Table 1.

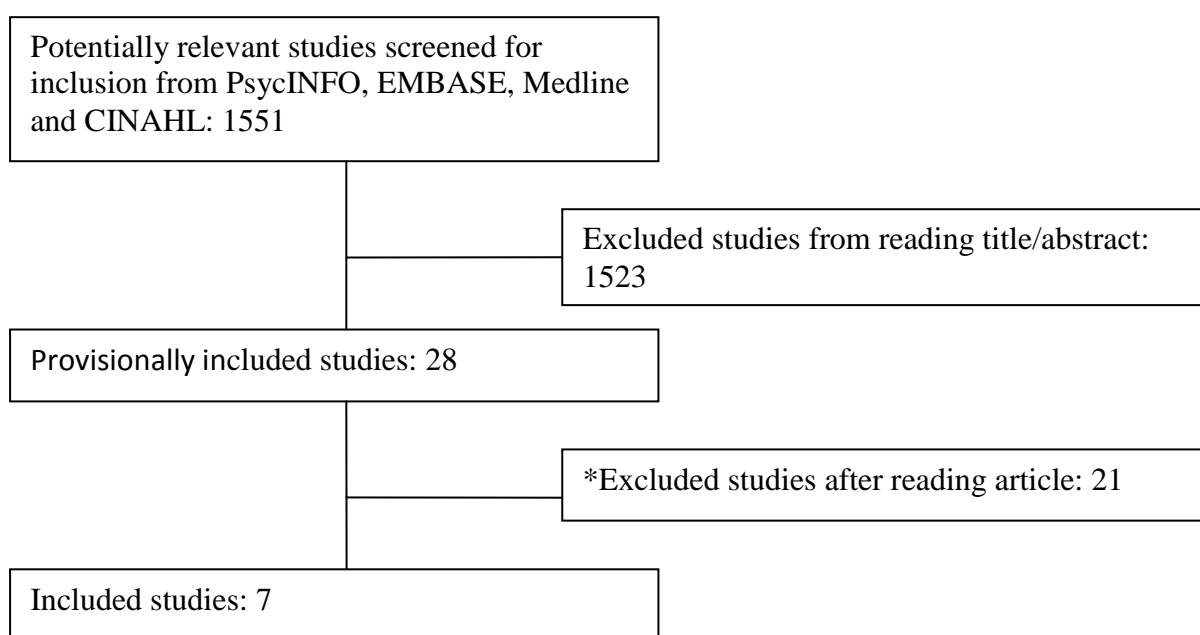
The seven papers that met inclusion criteria were reviewed in detail. Summary information from each article was identified and presented in Table 3. This included design, sample characteristics, treatment (duration, intensity, type and setting), dependent variables, results and outcome.

#### ***2.3.5 Assessment of quality of included studies***

It is important to assess the quality of the included studies to determine how much strength should be given to the results of each paper. It is likely that some findings are more valid than others after assessing their methodological quality. The quality of previous papers in this field of research had been established using the neurological

management guidelines of the European Federation of Neurological Societies (Hughes *et al.*, 2001) and the systems used in previous cognitive rehabilitation reviews (Cicerone *et al.*, 2000; Cattelani, Zettin & Zoccolotti, 2010). However, this method limited the quality rating, putting each study into one of only three groups (or classes) dependent on their methodological criteria. In the current review, a 10 item quality checklist was identified from a combination of the Cochrane guidelines and the NICE ‘quality appraisal checklist for quantitative studies’ (NICE, 2012; see appendix 1), where each study is given a quality rating so it is possible to differentiate between study results by reviewing each individual quality score.

**Figure 1. Flow chart of literature search process**



*\* 17 studies were excluded due to a lack of quantitative outcome measures; 1 study was excluded as it used an ABA intervention; 3 studies were excluded as the intervention used alternative medicine.*

The outcome ratings identified by SIGN (2008) for assessing the methodological quality of studies were used to assess the 10 quality criteria. There were six possible



outcomes under each criterion and each was associated with a quality score. The rating were as follows: 'well covered' (2 points); 'adequately covered' (1 point); 'poorly addressed', 'not covered', 'not reported', and 'not applicable' (all 0 points). The highest possible quality rating was 20.

As there is a degree of subjective analysis and therefore potential for bias in this process of quality assessment, SIGN (2008) recommend that the quality assessment should also be undertaken by a second researcher in order to ensure consistency. Consequently, the author and an appropriately qualified colleague both rated each paper. Cohen's K was run to determine if there was agreement between the two raters' judgements on quality rating of the seven papers. There was good agreement between the two raters' judgements,  $K = .78$ ;  $p = .029$  (classification of cohen's kappa was adopted from Altman, 1999). Discussions took place to identify the appropriate rating for the criteria where agreement was not reached.

## **2.4 RESULTS**

### ***2.4.1 Characteristics of included studies***

#### **Participants**

Overall, there were 199 participants included in this review over the seven studies. All participants had suffered an ABI, but the main pathology was TBI. All the studies included participants with a moderate to severe level of ABI. Two studies also included participants with a mild level of ABI.

**Table 3. Description of included studies (for key see end of table)**

Study ref. / country	Design	Sample  Characteristics/ Effect size	Treatment		Outcome measures	Results and outcome	Study limitations
			Duration  /intensity	Type / setting			
Cognitive Behavioural Therapy Studies							
Walker <i>et al.</i> (2010)  Australia	Repeated- measures design	N = 52  F : 12 M : 40  Mean Age: 32.3 (SD 11.3)  TPI: 4.1 years (SD 4.2)  ES: NR	9 x 12 weekly group sessions of 2 hrs/week.  Completed over an 8-year period.  Follow up after 7 months	CBT  Outpatient  Group sessions on anger manageme nt (4-8 patients per group, 2 clinicians per group)	STAXI	Positive result  Pre vs. post treatment  Sig. decrease in angry feelings and outward expression of anger.  Sig. increase in feeling in control of anger.  Effects maintained at follow up.	No control group so changes may demonstrate variability over time.  Measure does not include proxy ratings of behavioural observations.  Variability in content and delivery of group including modification for participants with differing cognitive impairment.
Aboulafia- Brakha <i>et al.</i> (2013)  Switzerland	Repeated measure design	N = 10  F: 2 M: 8  Mean Age: 47 (range: 24 - 58)  TPI: 27.5 months (range: 16 - 166)  ES: 1.04 (large)	8 x 60 minute group sessions	CBT  Outpatient  Group for anger and aggression (2-4 patients in each group)  Follow up after 4	AQ-12	Positive result  Sig decrease in level of aggression from baseline to follow up assessment (no sig decrease at initial post- treatment assessment)	Small sample size  Lack of proxy measures  Participants had high education level (>12 years) and low cognitive

				months			impairment level so results may not generalize to general population
Cognitive Rehabilitation Therapy Studies							
Fong & Howie (2009)  Hong Kong	Comparis on study	N = 27  <b>F: 6 M: 27</b>  (7 dropped out – does not state which gender)  <b>Mean Age:</b> 33.4 (SD 11.5 )  <b>TPI:</b> 12.3 years(SD 13.3)  <b>ES:</b> NR	15 weeks  22 sessions (1.15 hrs, 2 sessions/wk)  Follow up after 3 months	CRT  <i>Outpatient</i>  cognitive training  plus problem- solving training	SPSVM	<i>Limited result</i>  No sig. change on behavioural outcome measure	Measures were  not validated for Hong Kong, Chinese population.
Miotto <i>et al.</i> (2009)  Brazil	Repeated measure design	N = 30  <b>F: 15 M: 15</b>  <b>Mean Age:</b> 33.4 (SD 11.5 )  <b>TPI:</b> 12.3 years (SD 13.3)  <b>ES:</b> NR	10 weeks, 90 minute session per week	CRT;  Outpatient  3 xGroup- based attention and problem solving treatment focused on executive impairmen t. (10 patients per group)  Follow up after 6 months	DEX	<i>Positive result</i>  Sig. improvement on both functional assessments between pre and post treatment measures (maintained at follow up).  Sig. difference between experimental group and control.	Relatives were  not blind to the intervention so this may have influenced proxy ratings.
<u>Comprehensive – Holistic Approach Studies</u>							
Braden <i>et al.</i> (2010)  USA	Repeated measure design	N = 30  <b>F: 5 M: 28</b>  (3 dropped out – does not state which gender)  <b>Mean Age:</b> 33.4	13 weeks,  1.5 hrs/wk  Follow up at 6 months post- treatment	CHA  Outpatient  4 x Group  Interactive Structured Treatment	PPIC  SCSQ-A  GAS  SWLS	<i>Positive result</i>  Sig. improvement on measures of social behaviour post-treatment and maintained at	No control treatment   Small sample size

		(SD 11.5 ) <b>TPI:</b> 12.3 years (SD 13.3) <b>ES:</b> NR		for social competenc e (7 or 8 patients in each) Follow up after 6 months		follow-up	
McDonald <i>et al.</i> (2008)  Australia	RCT	<b>N</b> = 39 <b>F:</b> 11 <b>M:</b> 28 <b>Mean Age:</b> 35.5 (SD 11.3 ) <b>TPI:</b> 4 years (range 1 - 19) <b>ES:</b> NR	12 weeks,  Social skills group: 3 hours/week group session plus 1 hour/week individual session.  Social activity group: 4 hours/week	CHA Outpatient Social skills group (3 – 5 patients in a group) vs. social activity vs. waiting list control. (13 patients in each subject group)	BRISS-R (PCSS & PDBS)	<i>Mixed results</i> Sig. improvement in social behaviour with partner; no change in other behaviours.	Patients able to participate limited due to suitability and duration of treatment.  Effect sizes were smaller than initially thought  Small sample size  No follow up
Hart <i>et al.</i> (2012)  Pennsylvania	Repeated measure design	<b>N</b> = 10 <b>F:</b> 2 <b>M:</b> 8 <b>Mean Age:</b> 43.3 (range 23 - 59 ) <b>TPI:</b> 62 months (range 6 – 243) <b>ES:</b> NR	8 session 60 – 90 minutes each	CHA Outpatient Individual Self- monitoring training to build awareness of problem behaviour and learn strategies	STAXI-2  BAAQ	<i>Mixed result</i> Sig improvement on all self- reported measures (large effect size) No improvement on proxy measures	Small sample size  Internal validity in question as changes could be due to spontaneous recovery.

Key for Table 3:

N: number of participants; F : M: Ratios provided are Female: Male, unless percentage is provided.; MA: Mean age, this is given as a mean, with the range in brackets; TPI: Time post injury; ES: Effect size; CHA: Comprehensive Holistic Approach; CBT: Cognitive Behavioural Therapy; CRT: Cognitive Rehabilitation Therapy; STAXI: State-Trait Anger Expression Inventory; SPSVM: Social Problem-Solving Video Measure; DEX: Dysexecutive Questionnaire; PPIC: Profile of Pragmatic Impairment in Communication; SCSQ-A: Social Communication Skills Questionnaire – Adapted; GAS: Goal Attainment Scale; SWLS: Satisfaction with Life Scale; BRISS-R: Behaviour referenced rating system of Intermediary Social Skills – Revised; PCSS: Personal Conversational Style Scale; PDBD: Partner Directed Behaviour Scale; STAXI-2: State-Trait Anger Expression Inventory – Revised; BAAQ: Brief Anger Aggression Questionnaire

The site of the injury was reported in five of the papers. The majority of the participants had suffered frontal lobe damage, often combined with damage in another area of the brain. The length of time between injury onset and the start of treatment varied across the studies; from six months to 39 years. Time to treatment within each study also varied.

The socio-emotional behaviour difficulties that were reported, related predominantly to executive functioning. Three of the studies focused on symptoms of anger difficulties; manifest as verbal and/or physical aggression. The other four studies focused on a difficulty in daily functioning due to executive problems such as problem solving and difficulties with social cognition. All the studies reported difficulties that were having an impact on participants' socio-emotional functioning.

#### **2.4.2 Intervention**

All the papers employed a repeated-measure design with pre and post treatment measures. Follow up assessments were also carried out in five paradigms. The average length of time between treatment completion and follow up was between three and seven months.

The papers were divided into three categories: two papers focused on a CBT approach (62 participants); three papers used CHA (79 participants); and two studies looked at CRT (57 participants)).

The duration of the treatment varied, from a minimum of eight weeks to a 15-week period. All treatments were carried out in weekly sessions (group or individual) ranging from 60 minutes to 2.5 hours per week. Six of the seven studies used group sessions to administer treatment. One of these studies also included individual sessions (McDonald *et al.*, 2008), and another study used individual treatments for participants that were unsuitable to attend the group due to exclusion criteria (Fong & Howie, 2009). The final group study used individual treatment sessions only (Hart *et al.*, 2012).

All the group study participants were residing in the community. Most papers did not report where treatment sessions took place. Two group studies reported that the treatments were carried out in an outpatient rehabilitation unit.

To assess any socio-emotional behavioural problems, outcome measures used were generally standardized functional scales or self-rated questionnaires. There were also proxy measures used in 3 group studies. These were not necessarily the primary outcome measures.

### **2.4.3 Quality of included studies**

The quality ratings for the seven studies over the ten quality criteria, including a total quality rating, are presented in Table 4. It is important to note that this is not an exact comparative measure but it does provide an indication of the methodological strengths and weaknesses of each study.

The quality ratings indicate that McDonald *et al.* (2008) carried out the strongest methodological study, although the other studies showed average methodological quality.

#### ***2.4.4 Efficacy and effectiveness of socio-emotional behaviour interventions***

Overall, five of the papers found positive results for significantly reducing the maladaptive behaviour following treatment at T2. One paper had mixed results, where only the proxy rated measure showed positive results but not the self-rated measure (Miotto *et al.*, 2009) and one paper did not find a significant change following treatment (Fong & Howie, 2009). Within the papers that found significant change, three papers looked at the treatment of an outward expression of anger and two looked at inappropriate socio-emotional interactions. Three of these studies showed stability of the treatment effects at a follow up, T3, suggesting good effectiveness of treatment.

##### **CBT Intervention**

Both of the papers found positive results for significantly reducing the maladaptive behaviours (Walker *et al.*, 2010; Aboulafia-Brakha *et al.*, 2013). In both studies, participants initially had displayed verbal and/or physical aggression. These papers assessed behaviour at pre (T1) and post (T2) treatment and at a follow up assessment (T3). The studies both showed a significant decrease in outward expression of anger at T3 in comparison with T1 suggesting that the intervention showed some stability of outcome. Based on these two papers, it suggests that CBT could be a suitable



treatment for behavioural difficulties following ABI. However, both of these studies focus on the same anger related behaviour and cannot necessarily be generalised to other maladaptive behaviours that might manifest following ABI.

In addition, it would be premature to draw conclusions from only two papers of average methodological quality, especially when previous reviews in this area, have reported mixed results (Cicerone *et al.*, 2000, 2005; Cattalani *et al.*, 2010). These previous reviews recommended that CBT approaches within this population should include aspects that promote internalizing of self-regulation strategies through self-instruction or self-monitoring to help individuals with impaired executive functioning and emotional self-regulation. Both studies included in the current review utilised this process, which could account for the positive efficacy of the studies. Further research is needed to expand the evidence-base for using CBT for behaviour intervention in an ABI population before this intervention could be recommended as an effective option for standard practice.

#### CHA Intervention

All three studies found a significant positive change in behaviour in at least one outcome measure. Two of the studies focused on socio-emotional interactions (McDonald *et al.*, 2008; Braden *et al.*, 2010), whereas Hart and colleagues (2012) focused on behaviour related to anger. Two of these studies did not have a follow up assessment (T3). McDonald and colleagues only found a positive change using one outcome measure. They explained that a possibility for this was due to a lack of follow up. They speculated that it is possible that a period of time is needed to

**Table 4. Quality assessment for included studies.**

Study ref.	1	2	3	4	5	6	7
Walker <i>et al.</i> (2010)	WC	NR	PA	PA	WC	WC	NR
Fong & Howie (2009)	AA	NR	WC	AA	AA	WC	NR
Aboulafia-Brakha <i>et al.</i> (2013)	NR	NR	PA	AA	AA	AA	NR
Miotto <i>et al.</i> (2009)	WC	WC	AA	AA	PA	PA	NR
Braden <i>et al.</i> (2010)	AA	AA	PA	AA	PA	WC	NR
McDonald <i>et al.</i> (2008)	WC	WC	WC	PA	PA	WC	AA
Hart <i>et al.</i> (2012)	NR	NR	PA	PA	WC	WC	NR

WC= well covered; AA= adequately covered; PA= poorly covered; NR= not reported; NA= not applicable

Quality ratings: 1-6 = Poor; 7-14 = Average; 14-20 = Good

Key for Table 4:

1. Randomization: the assignment of subjects to treatment groups is randomized.
2. Allocation: an independent concealment of allocation procedure is used.
3. Baseline assessed: the treatment and control groups are similar at the start of the trial, with baseline scores described and differences assessed.

4. Confounds controlled: the only apparent difference between groups is the treatment under investigation (i.e. adequate statistical control or adjustment for confounding factors).
5. Outcome measures: primary outcome measures are evidenced to be both valid and reliable and psychometric values are specified by the authors.
6. Attrition: levels of attrition are reported and equivalent for treatment versus control
7. Intention to treat: ITT analyses are reported and missing values are imputed.
8. Power: A power calculation is reported and sufficient power is achieved.
9. Fidelity: the intervention is both sufficiently defined and delivered as planned (i.e. demonstrates good fidelity).
10. Generalizability: the trial demonstrates external validity in terms of evaluating the intervention for an appropriate duration and within a clinically relevant setting.

allow participants time to notice a change in behaviour. This is supported by another paper used in this review, as they only observed a significant change from T1 to T3 (Aboulafia-Brakha *et al.*, 2013). The positive results of these papers is supported by the findings in reviews by Cattelani *et al.* (2010), who stated that CHA should be the recommended standard practice for the treatment of socio-emotional behaviour problems following ABI. However, despite positive findings in all three papers, two of the three papers included in this review did not provide any clinical evidence for the effectiveness of this treatment approach.

#### CRT Intervention

Both of these studies focused on dysexecutive (socially inappropriate) behaviours. Fong and Howie (2009) did not show any significant change on the behaviour outcome measure. However, there were significant limitations of the outcome measure used. The other paper showed mixed results. The proxy measures used showed a significant decrease in maladaptive socio-emotional functioning and this was compared with control groups that did not show any significant change. These results were maintained at T3 showing some benefits over time. However, there were no significant findings on the self-rated outcome measures, which could be explained by a lack of participant insight (Miotto *et al.*, 2009). Overall, it is not possible to draw conclusions about treatment efficacy and effectiveness from these two papers. Due to the significant limitations of the only behaviour outcome measure used by Fong & Howie (2009), the strength of their results is limited.

There has been limited research in this area, but there is some evidence of the efficacy of CRT in clinical trials (Robertson, 1996; Rath *et al.*, 2003). However, there is little research and evidence that supports generalization of CRT. Therefore, there is no evidence-base to support CRT as an effective intervention for behavioural difficulties resulting from executive problems following an ABI (Rath *et al.*, 2003; Von Cramon *et al.*, 1991).

#### **2.4.5 Comparing intervention approaches**

It is not possible to come to definite conclusions based on the evidence available within this research field due to the limited number of studies published and the methodological limitations within the studies reviewed. Most of the participants included in this review had suffered a TBI and had suffered a moderate to severe brain injury. This limits the generalization of findings to all types and severity of ABI. In addition, there was a wide range of chronicity. Some participants were still within the initial phase of recovery (within one year), which could influence the results of studies due to a degree of spontaneous recovery. Most of the studies did not report a power calculation. Many also reported an insufficient sample size, which reduces the likelihood of attaining significant results. With these factors in mind, it would be premature to draw firm conclusions with regards to the effectiveness of the different treatment types.

### **2.5 DISCUSSION**

Following an ABI, individuals suffer from socio-emotional behaviour difficulties that affect their ability to reintegrate into the community and ultimately have a

negative impact on their quality of life (Dahlberg *et al.*, 2006). The socio-emotional behaviour consequences have been found to persist over time; often still present many years post injury (Koskinen, 1998). For this reason it is important that interventions for socio-emotional behaviour problems are considered an essential part of rehabilitation. Consequently, it is important to expand the research in this area to identify an effective evidence-based intervention.

This systematic review evaluates the efficacy and effectiveness of interventions for behavioural difficulties that have an impact on socio-emotional behavioural functioning in an ABI population. Only seven studies were identified that looked at interventions in this area within the past six years preceding this review. This highlights the limited research within this field.

Overall, this review showed that there were positive findings present on at least one outcome measure in six of the seven studies. This suggests that there is good efficacy for socio-emotional behavioural interventions within a ABI population. Unfortunately only four of these papers used a follow up measure, however, all four studies showed positive results suggesting good effectiveness of the interventions in an ABI population.

The papers that were identified were grouped into one of three types of intervention (CBT, CRT, and CHA). This review supported the findings of the review by Cattalani *et al.* (2010), suggesting that CHA showed good efficacy within clinical trials. The studies looking at CRT showed mixed results, and one of the two papers

also had significant limitations in methodology so no conclusions could be drawn on the efficacy and effectiveness of CRT in this population. This review did suggest that there might be potential in using a CBT approach for treating behavioural difficulties following ABI. However, a lack of evidence-base to support this approach limits any conclusions.

Although Cattalani *et al.* (2010) found similar findings, their results are also limited due to the quality criteria used within their review. They used a rating system based on the European Federation of Neurological Societies (Hughes *et al.*, 2001), which classified each study into one of three groups (Class I included all methodologically sound RCTs; Class II included all well designed case controlled studies or non-RCTs; Class III included all case studies). Due to this classification, Cattalani *et al.* (2010) only found five papers, of their 67 reviewed, fitted into a Class I, with the majority of the other studies in Class II. This made it difficult for a reader to identify the strength of evidence within each paper and could at times be misleading. For example, one paper included (Salazar *et al.*, 2000) was assigned to Class I concluding that the intervention used was ineffective. However, Prigatano (2003) identified that the intervention used was not designed for the population used within the study and that there were indications that the severity of impairment was milder than in other studies, although this had not been identified within the paper. For this reason, a relatively more in depth quality analysis was carried out within this review.

In addition case studies were included in the Cattalani *et al.* (2010) review but these present a problem with classification as their quality analysis was designed for RCTs

as the gold standard, always limiting the interpretation of case study evidence due to a problem with external validity. As the quality criteria in the current review was also created for RCTs, case studies were not included.

### **2.5.1 Limitations**

The systematic literature search was limited to papers that were published in English, papers were all from peer-reviewed journals. There is also limited validity of the quality criteria as there is potential for subjectivity to bias this analysis. However, having the studies independently rated mitigated this against. This demonstrated high inter-rater reliability.

The studies included in this review had considerable heterogeneity with regards to the individual variables present. This means that it is difficult to identify the impact of uncontrolled elements in the effects of interventions. This is a limitation that is often present in psychological research of an ABI population. Carney *et al.* (1999) suggested that it is important to limit this by limiting the inclusion/exclusion criteria on etiology, brain injury site, severity of clinical and cognitive presentation and time since injury. However, this would vastly limit the available sample of participants, reducing the chance of finding genuine effects of treatment within the population.

The papers included also had a variety of socio-emotional behaviour problems, intervention approaches, outcome measures, treatment duration and follow-up periods. Although the inclusion and exclusion criterion was used to limit this range, this heterogeneity undoubtedly limited the review conclusions.



Within the current review and previous reviews (e.g. Cattalani *et al.*, 2010), the quality criteria is based on the idea that the strongest evidence is provided within RCTs. Generally RCTs are favoured over other methodologies as they account for biases. However, this framework was originally created for medical drug trials but due to practical and ethical reasons is not appropriate in the research of behavioural interventions (Kennedy & Turkstra, 2006).

### ***2.5.2 Implications for research and clinical practice***

The small number of papers considered suitable for this review highlights the lack of recent research in this field. Further research is needed to determine the effectiveness of socio-emotional behaviour interventions in an ABI population. Although the SIGN guidelines (2013) recommend a CHA in addressing behavioural difficulties following brain injury, this is based on limited evidence. Despite positive findings in studies, the other interventions, such as CBT, have not been recommended due to a similarly restricted evidence base.

A possible reason for the limited research in this area is the complexity of carrying out research with this population. Some of the difficulties in evaluating interventions in this population are highlighted in this review. These include the range in pathology, brain damage severity, site of damage, chronicity, severity of cognitive impairment, and the severity and specific type of the target behaviour. There is also likely to be a confounding bias due to the possibility of pre-existing or comorbid psychiatric conditions. Future studies should consider limiting some of these factors

by using a more rigorous inclusion/exclusion criteria to focus each study looking at an intervention on a more specific sample of individuals with ABI (Carney *et al.*, 1999).

This review highlights the key areas of methodological weakness that should be improved in future studies (for example, using power calculations to justify sample size and employing a suitable method of randomisation for allocating treatment). In addition, the design and contents of treatments should be clearly stated along with a better specification of the underlying theory.

Clinically, the literature highlights the importance of rehabilitation focused on socio-emotional behaviour following ABI to combat the negative impact on everyday functioning, community integration and quality of life. This highlights the importance of research in evaluating the effectiveness of these interventions over time and how treatment effects are generalized to everyday social functioning. Therefore, future research should include standardised assessment tools that reflect the impact on everyday life (e.g. social participation and quality of life measures).

### **2.5.3 Summary and conclusions**

Overall, findings within the current review and the Cattelani *et al.* (2010) review are indicative that a socio-emotional focused intervention may be effective following ABI. More specifically, there is some support for a CHA treatment approach. However, these conclusions should be taken tentatively due to the limited research

available and the methodological limitations within these studies, and also within the current review.

Finally, this review highlights the lack of evidence-based interventions for socio-emotional behaviour difficulties following ABI. Due to the limited research on the underlying cognitive deficits underpinning these socio-emotional behavioural difficulties, it may be important that further research is carried out to identify these cognitive factors. This could help to identify the focus of treatment and help build the evidence required to identify a ‘gold standard’ intervention. This review shows the importance of research in an ABI population due to the considerable impact of socio-emotional behavioural difficulties on the individual, family and society.

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### **3. Journal Article: Neuropsychological deficits associated with socio-emotional behaviour problems following Traumatic Brain Injury (TBI)**

#### **3.1 ABSTRACT**

**Introduction:** To investigate the relationship between social cognition and behaviour post-TBI, social cognition was split into categories (emotion recognition, theory of mind, and cognitive flexibility). This follows Corrigan's Adequate Social Behaviour Model.

**Methodology:** Forty TBI participants and forty healthy controls were asked to carry out two emotion recognition tasks, four theory of mind (ToM) tasks (two verbal and two visual), two cognitive flexibility tasks, and measures of processing speed, attention and working memory. Within the TBI group, two self-rated and two proxy-rated (completed by a carer or relative) socio-emotional behaviour measures were administered.

**Results:** The TBI group performed significantly poorer than controls on measures of emotion recognition, three ToM tasks and on measures of processing speed and working memory (executive function). There was no association found between performance on any of the cognitive tests and socio-emotional behaviour.

**Discussion:** Differences found between the TBI and control groups on measures of cognitive functioning are consistent with previous research. Performance on measures of emotion recognition, ToM and cognitive flexibility were not associated with the severity of the socio-emotional behaviour problem following TBI. Similar results were also reported by Milders *et al.* (2008); questioning the validity of Corrigan's Model in a TBI population.

**Key words:** Traumatic brain injury, socio-emotional behaviour, social cognition, cognitive function

(Abstract: 199 words; Main report: 6345 words)

## **3.2 INTRODUCTION**

Following traumatic brain injury (TBI), it is common for an individual to suffer socio-emotional (emotional and social) behaviour changes such as emotional lability, difficulty in making appropriate social judgements and communications, and making impulsive decisions and actions (Kendall & Terry, 1996; Milders *et al.*, 2008). It is well documented that, following TBI, changes in emotion and social behaviour can result in poorer patient rehabilitation; specifically limiting vocational outcome (e.g. Lezak & O'Brien, 1988), social integration (e.g. Oddy, Coughlan, Tyerman & Jenkins, 1985) and the quality of marital relationships (e.g. Parente, DeCesare & Parente, 1990). There is also a higher level of perceived burden on family members linked with these behavioural changes (e.g. Oddy & Humphrey, 1980) rather than the physical or cognitive deficits following TBI (Brooks, Campsie, Symington, Beattie, & McKinlay, 1986). These emotional and social behavioural changes have been found to persist over time; with the socio-emotional consequences still evident many years post injury (Koskinen, 1998).

### **3.2.1 The role of the frontal lobes and executive functioning**

It is widely recognised that the frontal lobes play a vital role in social cognition and influence behavioural responses (Baron-Cohen *et al.*, 1994; Blair & Chipolotti, 2000; Blumer & Benson, 1975). The frontal lobes and their associated pathways are commonly damaged as a result of TBI (Channon & Crawford, 2010). Studies have shown that patients with frontal lobe damage can be impaired on tasks of emotion recognition (Blair & Chipolotti, 2000; Hornak, Rolls & Wade, 1996), ToM (Baron-

Cohen *et al.*, 1994; Gallagher *et al.*, 2000) and cognitive flexibility (Blumer & Benson, 1975). Damage to the frontal lobes has also been linked with socio-emotional behaviour problems as a result of executive dysfunction (Sohlberg & Mateer, 2001). Of those problems identified, lack of insight, distractibility, disinhibited reasoning and behaviour, an inability to suppress automatic responses due to impulsivity, and difficulties in self-monitoring, are often reported (Blumer & Benson, 1975, Lezak, 2004).

Other studies that have also looked at the relationship between cognition and socio-emotional behaviour post-TBI, Kendall and Terry (1996) highlighted cognitive dysfunction as a factor that contributes to post-TBI behaviour. In addition to the research showing links between executive function and socio-emotional behaviour, studies have also looked at the relationship between behaviour and memory, processing speed, and attentional deficits (Bowman, 1996; Vilkki *et al.*, 1994). All of which have provided limited contribution. Further research into the potential mediating role of underlying cognitive deficits could potentially bring numerous benefits. For instance, it might enable us to better predict behaviour problems in patients. This could lead to improved care by identifying the most effective early intervention strategies to ameliorate such difficulties, thus potentially impacting upon outcome in this patient group.

### **3.2.2 Corrigan's model of Adequate Social Behaviour**

When investigating the relationship between theoretical constructs, it is helpful to use an established framework. Corrigan's (1997) model of Adequate Social



Behaviour was used as a framework for this study. Although the model was originally created for use with patients with Schizophrenia, this three-stage model appears to provide a reasonably robust description of key psychological processes involved in social functioning. The first stage involves the perception of emotional cues in a social context (i.e. emotion recognition). The second stage is the ability to understand these cues by retrieving appropriate social knowledge that enables insight into other people's intentions (i.e. apply theory of mind). The final stage requires the individual to be able to select an appropriate response or behaviour for the situation (i.e. demonstrate mental flexibility). Corrigan proposed that deficit in any one of these processes will result in 'inadequate' social functioning.

#### Emotion recognition

Following TBI, patients have often been shown to display deficits in the recognition of social cues (stage one of Corrigan's Adequate Social Behaviour model); specifically in emotion recognition (Hopkins, Dywan & Segalowitz, 2002, Milders, Fuchs & Crawford, 2003). Previous studies have reported a link between a deficit in emotion recognition and socio-emotional behaviour problems following a TBI. For example, Petterson (1991) showed this relationship in children following head injury; with those who had difficulty in identifying emotions also being found to show more maladaptive socio-emotional behaviours.

#### Theory of mind

ToM involves an ability to understand another individual's state of mind. This incorporates an individual's ability to understand other people's intentions (stage two

of Corrigan's Adequate Social Behaviour model). Numerous studies show impairment in this ability following TBI (Channon & Crawford, 2000; Milders *et al.*, 2003). Some researchers also suggest a relationship between ToM and post-TBI socio-emotional behaviour problems (Cicerone & Tanenbaum, 1997; Milders *et al.*, 2003). More specifically, studies found that a task measuring social inference was associated with emotional and social behaviour (Gregory *et al.*, 2002; Milders *et al.*, 2003).

### Cognitive flexibility

Response selection (cognitive flexibility) allows an individual to choose the socially appropriate verbal or behavioural response given the demands or context of a situation (stage three of Corrigan's Adequate Social Behaviour model). Cognitive flexibility (an executive functioning skill) has been repeatedly shown to be vulnerable to impairment following TBI (Levin, 1995), and a link between this deficit and socio-emotional behaviour has also been reported (Prigatano, 1992). A link with socio-emotional consequences has also been highlighted; showing that competency on measures of cognitive flexibility is associated with vocational outcome and social participation following TBI (Nybo, Sainio & Muller, 2004; Vilkki *et al.*, 1994).

The above evidence appears to suggest that individuals can suffer impairments in each of the three processes of Corrigan's Adequate Social Behaviour model following TBI. Corrigan's (1997) model predicts that there would be 'inadequate' social functioning if impairment exists in any one of these stages.

### **3.2.3 Post-TBI behaviour and social cognition**

Using Corrigan's (1997) model of Adequate Social Behaviour as a framework for describing key psychological processes involved in 'adequate' social functioning', Milders and colleagues (2008) looked at post-TBI socio-emotional behaviour and the possible underlying social cognitive deficits (specifically in emotion recognition, ToM, and cognitive flexibility). Social cognition is defined as the cognitive abilities required for processing, storing, and using information needed to interact successfully with other people. Although they found an increase in socio-emotional behavioural problems one year post-injury, they did not find an association with performance on social cognitive measures. They suggested that this might question the relationship between socio-emotional behaviour and social cognition as hypothesised in Corrigan's (1997) model. However, it would be premature to make definite conclusions from this individual study.

As in the research by Milders and colleagues (2008), this study further explored associations between emotional and social behavioural difficulties and neuropsychological competencies that are considered important for social functioning, based upon Corrigan's (1997) Adequate Social Behaviour model. Unlike Milders and colleagues (2008) study, participants that formed the TBI group were selected if they had post-TBI behavioural problems, as reported by their Clinical Neuropsychologist or family members. Furthermore, the present study will also utilise a larger range of neuropsychological assessments, including measures for processing speed and working memory; both of which have been shown to be related to post-TBI socio-emotional behaviour (Bowman, 1996; Vilkki *et al.*, 1994).

### **3.2.4 Current study**

Neuropsychological assessments were carried out with a TBI population in order to evaluate the potential contribution of cognitive variables to the three stages (emotion recognition, ToM and cognitive flexibility) of Corrigan's model. Self and proxy-rated questionnaires were also completed to assess emotion and social behaviour.

The purpose of this research was to explore whether impairments in emotion recognition, theory of mind, or cognitive flexibility might be associated with socio-emotional behaviour following traumatic brain injury (TBI). The aims included 1) identify if there are any differences between a TBI population and control group in performance on measures of social cognition and other cognitive measures and 2) to look at any potential relationships between socio-emotional behaviour and measures of cognition. Two hypotheses were proposed for this study:

*Hypothesis 1:* Due to previous research, it was hypothesised that the TBI group would have significantly poorer performance compared with controls on all cognitive measures.

*Hypothesis 2:* There will be a relationship between socio-emotional behaviour and social cognition within a TBI population. As there is limited research into this relationship, the second aim was mainly explorative; therefore we did not have a directional hypothesis.

### **3.3 METHOD**

#### **3.3.1 Power analysis**

For hypothesis 1, 'GPOWER' version 3.1 (a statistical package used to calculate sample size) was used to carry out a formal sample size calculation (Faul & Erdfelder, 1992). This calculation suggested that a sample size of 111 is required for detection of a large effect size ( $f = .40$ ) at an alpha level of .05 and power of .80 for MANOVA (Cohen, 1992).

For hypothesis 2, the same statistical package was used to carry out a formal sample size calculation. This calculation suggested that a sample size of 132 is required to detect a large effect size ( $r = .50$ ) at an alpha level of .05 and power of .80 for Pearson's Correlations (Cohen, 1992).

A large effect size was chosen due to similar effect sizes achieved by previous research in this area (Milders *et al.*, 2008). The effect sizes for hypothesis 1 and 2 used different measures of effect size. Large effect size is represented by a different value for Cohen's  $f$ , used to measure the effect size for MANOVA, and for Pearson's correlation coefficient ( $r$ ), used to measure the effect size for correlation analysis. This also results in a different sample size to reach the power required for each analysis.

#### **3.3.2 Participants**

##### **TBI Group**

Participants who had suffered a single incident TBI were recruited from a database of

patients who had been previously assessed at the Department of Neuropsychology within NHS Grampian. For inclusion participants were required to meet the following criteria:

- Aged between 18 and 70 years
- Documented past history of mild, moderate or severe TBI
- Existing social difficulties (as reported by the clinician or the individual's family).

Individuals were excluded if they had any of the following:

- Neurodegenerative disorder (e.g. dementia), major psychiatric history (e.g. psychosis), or alcohol/drug dependencies.
- No capacity to consent to participate (as judged by the Clinical Neuropsychologist previously involved in their care).
- A premorbid learning disability.
- A problem with facial recognition or language comprehension (screening measures used).

### Control Group

Data was also collected from a sample of healthy adults. Exclusion criteria were the same as for the TBI group, but for the control group they were also excluded if they had ever suffered any type of brain injury. They were also screened for facial recognition difficulties and language comprehension deficits.

### Additional participants

A relative was also recruited for each TBI participant to generate proxy ratings on the participants' premorbid and post-injury social behaviour. The proxy ratings were all completed by a spouse with the exception of six proxy raters, whom were parents of the individual with ABI. All participants gave informed consent to take part in the study.

### Participant demographics

The TBI group and the control group had 40 participants in each. The groups did not differ in terms of male to female ratio,  $\chi^2(1) = 1.73, p = .189$ . There was a significant difference in age,  $t(N = 80) = 2.63, p < .01$ , when an independent-samples t-test was carried out. The TBI group,  $M = 40.1, SD = 13.2$  years, was significantly older than the control group,  $M = 32.3, SD = 13.3$  years. There was no significant difference in terms of years of education between groups,  $t(78) = -1.37, p = .176$ .

The TBI group varied in brain injury severity. Participants were asked to report their length of Post-Traumatic Amnesia (PTA) but the majority could not remember and others did not report experiencing PTA. Only 47.5% of the sample reported PTA, ranging from 0 – 7 days, suggesting a wide range of mild to severe level of TBI, however, average score indicates that this sample of participants represents a more severe (PTA > 2 days) TBI group ( $M = 2.39$  days,  $SD = 2.31$ ). Information regarding the site of injury was not available. The length of time since injury varied from six months to twenty years ( $M = 4.97$  years,  $SD = 4.86$ ).

### **3.3.3 Materials**

The measures used in this study looked at pre and post-injury behaviour of the TBI sample. The other measures utilised evaluated the three stages of Corrigan's (1997) model: emotion recognition, theory of mind, and cognitive flexibility. To ensure that the function or behaviour being evaluated did not solely relate to the instrument used, more than one measure was used for each social cognitive domain of interest. Measures of cognitive function were also administered. Two screening measures were completed to ensure there were no impairments in language comprehension and facial recognition.

#### Screening Measures

The Complex Ideation subtest from the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983) was used to screen for language comprehension. The Benton Facial Recognition test (short form; Benton, Sivan, Hamsher, Varney & Spreen, 1994) was used as a screen for facial perception difficulties. All participants ( $N = 80$ ) were screened and did not have any facial perception or language comprehension deficits when checked against standardized norms.

#### Cognitive functioning measures

Two measures assessing cognitive processes that have previously been linked to behaviour change in individuals following TBI (Struchen *et al.*, 2008) were included. Widely approved, standardised measures were used to assess processing speed (Trail Making Test, Part A; from the Army Individual Test of General Ability: Reitan, 1958), attention and registration of information (Digit Span Forwards), and working



memory (Digit Span Backwards; from the Digit Span subtest of the WAIS-III: Wechsler, Wycherley, Benjamin & Crawford, 1998).

*Socio-emotional Behaviour questionnaires*

***The Dysexecutive Questionnaire – Proxy version*** (DEX: Wilson, Alderman, Burgess, Emslie & Evans, 1996) consists of 20 items asking about level of social participation. For each item, the rater is required to choose a score from a five-point scale. Higher scores indicate greater difficulties and so less independence. The proxy version was completed by a carer, family member, or close friend of the participant. This measure was chosen as it has been used widely in a TBI population and has been found to be sensitive to executive dysfunction and frontal lobe injury (e.g. Bennett, Ong & Ponsford, 2005). It has also been shown to have good validity and reliability ( $\alpha = .92$ ; Chaytor & Schmitter-Edgecombe, 2007) within this population (Norris & Tate, 2000; Wilson *et al.*, 1996).

***The Community Integration Questionnaire*** (Willer, Ottenbacher & Coad, 1994) is a 15 item questionnaire that looks at integration into society (for example, number of times visiting friends per week) and independent productive activities within the home (for example, cooking and house chores). This measure has also been used widely in a TBI population and has been shown to have concurrent validity in this patient group (Saeki, Okazaki & Hachisuka, 2006). Other studies also suggested that this measure has good validity and reliability ( $\alpha = .79$ ; Salter *et al.*, 2008) within this population (Dijkers, 1997).

***The Neuropsychological Behaviour and Affect Profile*** (Nelson, Drebing, Satz & Uchiyama, 1998) measures the neuro-cognitive, emotional and behavioural difficulties post brain injury (specifically depression, mania, indifference, inappropriateness and pragnosia). For each of the 106 items it asks the rater to identify if the individual had experienced this before and after injury to identify change. In this study, both the self and proxy versions were used. This measure has shown good internal reliability ( $\alpha = .92$ ; Cannon, 2000), criterion validity, and construct validity when used in a TBI group (Mathias & Coats, 1999).

### *Emotion recognition*

***The Morphed Face Task*** (Calder *et al.*, 1996; based on Ekman's face task: Ekman & Friesen, 1976) displays subtle blends of emotions. Items are considered more realistic than the original Ekman's faces. With the original Ekman's task criticised for being too obvious, the blended nature of items on the Morphed Face Task is considered more representative of everyday subtleties in facial expressions (Ietswaart, Milders, Crawford, Currie & Scott, 2008). The test consists of 60 photographs of 10 individuals' faces expressing fear, disgust, anger, happiness, sadness, or surprise. Photographs are displayed one at a time with the six possible emotion words presented alongside. Participants are asked to select the emotion that best describes the facial expression displayed. One point is awarded for each correct answer, so there is a maximum score of 60. This measure was selected as previous studies have shown that a TBI group performed worse than a control group on this updated version of the Morphed face task (Ietswaart *et al.*, 2008; Milders *et al.*, 2008).

***Dynamic Faces task: The Cambridge Mindreading task's*** (CAM: the face-voice battery) ***emotion identification measure*** was based on a pilot test by Golan, Baron-Cohen and Hill (2006). In this task, the participant is presented with a short, soundless video clip of an individual's face expressing an emotion. There were twenty different emotions used within this task. Following the video clip, the participant is given a choice of four emotions (for example, vibrant, nostalgic, guarded and indifferent) from which they identify the most appropriate emotion to describe the clip. The four emotion options changed with each video clip. The participants were also given the definition of each emotion presented to reduce the influence of verbal comprehension in the task. This measure has not yet been used with a TBI population. However, it was selected as it is a dynamic measure (i.e. presents video clips of moving faces, rather than static pictures); with the facial expressions presented in the video clips arguably being more realistic than others used in similar measures (Cohen & Hill, 2006). This is because the videos show more subtle differences and they cover a larger variety of emotions (rather than the standard six used in the Morphed Face Task).

### *Theory of Mind*

Two verbal and two nonverbal measures of ToM were used so as to account for any difficulty in either of these domains following the individual's TBI.

***The Faux Pas Test*** (Stone, Baron-Cohen & Knight, 1998) evaluates participant's ability to identify socially inappropriate behaviour, and understand the mental state of characters and how they would feel in a given situation. The test includes 20 short

vignettes, half of which describe a situation with a social faux pas present (i.e. where violation of a socially accepted norm takes place). Participants were required to identify if a faux pas had taken place, the intent and feelings of the character that had made the faux pas, and the feelings of the character that the faux pas was directed at. A control question was also asked to ensure understanding of each story. Maximum score for Faux Pas detection was 20. The Faux Pas Test was selected as it is an adult measure of ToM. It is not yet a standardised measure, but in previous papers, results on this measure have shown a link with behaviour (Gregory *et al.*, 2002; Milders *et al.*, 2003, 2006).

***The Hinting Task*** (Corcoran, Mercer, & Frith, 1995) looks at participant's ability to infer the *real* meaning behind statements that do not directly address the intended topic. For example, the participant is told that George is shopping with his mum, George says, "Cor, those treacle toffees look delicious". The participant is asked 'what does George really mean when he says this?' Two points are awarded if the participant identified that George wants his mum to buy them for him. One point is awarded if they need an additional verbal prompt to come to the correct answer. There are 10 items so the maximum score is 20. This task has previously been used in a TBI population and has highlighted deficits in individual's ability to identify hidden meaning behind comments; therefore failing to understand the intentions of the characters in the stories (Channon, Pellijeff & Rule, 2005).

***ToM cartoons test*** (Vollm *et al.*, 2006) is a nonverbal measure in which participants are required to infer the intentions of a main character to establish the predicted

consequence. Participants were presented with a cartoon strip showing a sequence of 3 pictures. They were then asked to select the most likely ending from a choice of 2 possible cartoon pictures. One point was awarded for each correct response on 40 items. This test has previously been used in a Schizophrenic population (Vollm *et al.*, 2006).

***Cartoon predictions*** (O'Sullivan & Guilford, 1976) is a nonverbal test of social understanding. Participants are required to make inferences regarding the feelings and intentions of characters in a cartoon picture, accompanied with a written prompt. The participant is asked to predict what is likely to happen next by selecting the most socially appropriate cartoon picture from a choice of three. There are 10 test items, with a score of 1 awarded for each correct answer. A sample item is included to ensure participants understood the task. Cartoons are used to reduce the influence of verbal ability, memory and general intelligence. Eslinger, Moore, Anderson and Grossman (2011) used this measure in Frontal-type dementia, where they found a significant deficit in this task when compared to control performance. Mah, Arnold and Graftman (2005) also found impairment on this task in patients with frontal lobe damage when compared to a control group and they also showed a link with socio-emotional behaviour.

### *Cognitive flexibility*

***The Golden Version of the Stroop test*** (Golden, 1978) is a revised form of the original Stroop test (Stroop, 1935). This test provides a measure of inhibition (executive function behaviour) and involves presenting participants with three tasks.

The first task, word card (W), required them to read out 100 colour words (all words were a colour, e.g. blue, green, yellow, red) written in black ink; the second task, colour card (C), involved saying out-loud the colour of the ink of 100 items (each item presented as 'XXXX'); in the third task, word-colour card (WC), the participant was asked to say aloud the colour of the ink that 100 colour words were written in. Participants were given 45 seconds to complete as much items as possible on each task and the number completed was recorded. The overall score was identified by dividing the C task score with the WC score to create a ratio. The Stroop test is a common measure of cognitive flexibility; specifically looking at an individual's ability to inhibit responses. This measure shown good reliability ( $\alpha = .73$ ; Golden, 1976) and has been widely validated in a TBI population (e.g. Ben-David *et al.*, 2011).

***The emotional GO/NoGO task*** used in this study was based on the task used by Wessa and colleagues (2007). The Go-NoGo task assessed inhibition deficits (responding in Nogo trials). In the emotional Go-NoGo task, photographs of faces were flashed on a computer screen for 3 seconds. The facial expressions either presented with happy or fearful emotions. The participant was required to press the space bar on the keyboard as quickly as possible when they saw the target emotion, a happy face (Go), but to withhold the response to a distractor emotion, a fearful face (NoGo). The computer recorded if the answer was correct.

### **3.3.4 Procedure**

Participants were tested individually by four assessors who carried out the two hour-long test battery either in a room at the Psychology Department in the University of Aberdeen, or in a hospital clinic room. All the participants chose to complete the battery in one sitting although they were offered to complete it over two sittings. The participants were given a ten-minute break in the middle of testing. The order of the testing was varied in an ordered manner for each participant to reduce order-effects.

The self-rated questionnaires were completed by the participant as part of the test battery. The proxy questionnaires were sent out with the appointment confirmation two weeks prior to the test session. Within this two week period these questionnaires were completed and returned when the participant attended the appointment.

## **3.4 RESULTS**

### **3.4.1 Exploratory analysis**

Exploratory analysis was carried out to look at test data distribution by plotting P–P plots and histograms for all outcome variables. The distributions were reasonably symmetrical for most of the data (Field, 2013). However, ‘the central limit theorem states that when samples are large (above about 30), the sampling distribution will take the shape of a normal distribution, regardless of the shape of the population from which the sample was drawn’ (Field, 2013). Thus this proposes an assumption of normal distribution for a sample over 30; due to the size of the data set (TBI group:  $n = 40$ ; control group:  $n = 40$ ), normality was assumed and parametric analysis was used (Field, 2013). Boxplots and scatterplots were carried out to screen

for potential outliers. Further, z-scores were computed for each of the dependent variables of all tasks using a statistical programme. Normally a data point with a z-score less than -3.29 or greater than +3.29 is considered to be outliers in a normally distributed data set (Field, 2013). Using this criterion, no outliers were identified.

The missing data was handled by selecting a discrete value to code for all missing values in SPSS (Field, 2013). The full analysis was then re-run after accounting for missing values. No significant differences were found between the analyses before and after controlling for missing data.

#### ***3.4.2 Performance on cognitive measures: a comparison of means between groups***

Initial analysis looked at any differences in performance between the TBI and control groups. As there were multiple dependent variables a multiple analysis of variance (MANOVA) was used throughout the study. Assumptions of MANOVA were met. Age was then entered as a covariate due to the significant difference in age between the TBI and control groups (MANCOVA). This was to ensure that any significant differences found between groups on task performance were independent of the effect of age. Pillai's trace statistic was used due to recommendations by Field (2013), who argued that Pillai's trace is the most powerful statistic when 'groups differ along more than one variate'. A discriminant analysis process was not needed following the MANOVA as there were only two groups (Field, 2013). Mean scores and standard deviations of the neuropsychological tests for the TBI group and control



subjects are shown in Table 1. This table also presents the significance of the comparison of means. Estimated effect sizes are also represented as eta squared ( $\eta^2$ ).

### Emotion recognition

Using Pillai's trace, there was a significant main effect of group on emotion recognition performance,  $V = .259$ ,  $F(2,76) = 13.27$ ,  $p < .001$ ,  $\eta^2 = .259$ . The results show that the TBI group performed significantly poorer than the control group on both tests of emotion recognition as shown in Table 1. After age was entered as a covariate, the main effect of group on emotion recognition remained significant,  $V = .259$ ,  $F(2,75) = 12.20$ ,  $p < .001$ ,  $\eta^2 = .246$ . The differences in performance on the emotion recognition tasks between groups remained significant: Ekman's Morphed Faces task,  $F(2,76) = 9.09$ ,  $p < .001$ ,  $\eta^2 = .193$ , and Dynamic Face task,  $F(2,76) = 13.40$ ,  $p < .001$ ,  $\eta^2 = .261$ .

Using Pillai's trace, there was a significant main effect of group on ToM performance,  $V=.243$ ,  $F(4,72) = 5.79$ ,  $p < .001$ ,  $\eta^2=.243$ . As shown in Table 1, the TBI group performed significantly poorer than the control group on the Guilford Cartoon Predictions, the ToM Cartoon Test and the Faux Pas Test. There was no significant difference between groups on Hinting task performance. Box plot analysis showed a ceiling effect on the Hinting task.

**Table 1: Inferential statistics on neuropsychological measures**

Measure	TBI M (SD) n	Control M (SD) n	F (df)	p	Eta squared
<b><u>Emotion Recognition</u></b>					
Morphed Faces (max score: 30)	24.03 (4.07) n = 40	28.35 (1.87) n = 39	10.1 (1,77)	<b>*.002</b>	.115
Dynamic Faces (max score: 20)	15.14 (3.16) n = 40	19.15 (1.27) n = 39	25.53 (1,77)	<b>*.001</b>	.249
<b><u>Theory of Mind</u></b>					
Hinting Task (max score: 20)	17.95 (1.92) n = 37	18.47 (1.89) n = 40	1.32 (1,75)	.254	.017
Faux Pas Test (max score: 20)	16.54 (4.05) n = 37	18.78 (1.90) n = 40	10.82 (1,75)	<b>*.002</b>	.126
ToM Cartoon Test (max score: 40)	36.74 (2.70) n = 37	38.65 (1.23) n = 40	16.33 (1,75)	<b>*.001</b>	.179
Cartoon Predictions (max score 10)	8.90 (1.56) n = 37	9.70 (.564) n = 40	9.79 (1,75)	<b>*.003</b>	.115
<b><u>Cognitive Flexibility</u></b>					
Stroop Task (score is ratio: WC/C)	.598 (.111) n = 27	.644 (.079) n = 30	3.38 (1,55)	.072	.058
GoNoGo Hits (max score: 42)	39.7 (4.52) n = 27	39.67 (1.90) n = 30	.002	.967	.000
<b><u>Other Cognitive Measures</u></b>					
Trail Making Test (time in seconds to complete task)	34.06 (25.1) n = 38	17.07 (10.7) n = 40	14.76 (1,76)	<b>*.001</b>	.163
Digit Span Forward	8.81 (2.14) n = 37	9.58 (1.68) n = 40	2.89 (1,75)	.093	.037
Digit Span Backward	6.17 (1.78) n = 37	7.95 (2.39) n = 40	13.76 (1,75)	<b>*.001</b>	.155

Note: \* significant at adjusted alpha level.

### Theory of Mind

After age was entered as a covariate, the main effect of group on ToM tasks remained significant,  $V = .205$ ,  $F(4,71) = 4.57$ ,  $p < .01$ ,  $\eta^2 = .205$ . The differences in performance on tests of ToM between groups remained significant on the Guilford Cartoon Predictions,  $F(2,74) = 5.42$ ,  $p < .01$ ,  $\eta^2 = .128$ , the ToM Cartoon Test,  $F(2,74) = 10.15$ ,  $p < .001$ ,  $\eta^2 = .215$  and the Faux Pas Test  $F(2,74) = 5.57$ ,  $p < .01$ ,  $\eta^2 = .131$ .

### Cognitive Flexibility

Using Pillai's trace, there was no significant main effect of group on cognitive flexibility performance,  $V = .060$ ,  $F(2,54) = 1.72$ ,  $p = .188$ ,  $\eta^2 = .188$ . As shown in Table 1, the TBI group did not differ significantly from the control group on the Stroop task or the GoNoGo task.

### Other Cognitive Measures

ANOVAs were conducted separately for each of the other cognitive measures. As shown in Table 1, the TBI group performed significantly poorer than controls on the Trail Making Test (processing speed) and the Backward Digit Span task (working memory). There was no significant difference between groups in performance on the Forward Digit Span task (attention and registration of information). When age was entered as a covariate, the difference remained significant between groups on the Trail Making Test,  $F(2,75) = 8.67$ ,  $p < .001$ ,  $\eta^2 = .188$ , and the Backward Digit Span task,  $F(2,74) = 6.82$ ,  $p < .01$ ,  $\eta^2 = .156$ .

### **3.4.3 Investigating relationship between cognition and post-TBI behaviour**

To investigate whether any stage of Corrigan's Social model was related to post-TBI behaviour, bivariate correlation analysis (Pearson's  $r$ ) was carried out for the TBI group. To control for multiple comparisons Bonferroni correction was applied. The significance level of .05 was divided by the number of correlations (four behaviour measures x seven cognitive domains = 28 correlations). Therefore, for an individual correlation to be significant, the  $p$  value must be less than .002 (Field, 2013).

The results showed that both of the emotion recognition measures were highly correlated ( $r = .756, p < .001$ ). There were also significant correlations between the four measures of theory of mind ( $r = .402 - .498, p < .01$ ). Therefore, to reduce the number of correlations, composite scores were obtained for the emotion recognition and theory of mind stages of social cognition. The composite score was created by converting the raw data into percentages for each measure. These percentage values were added together and divided by the number of measures. This gave a total percentage correct score for emotion recognition ( $N = 79, M = 77.9, SD = 14.69$ ) and for theory of mind ( $N = 77, M = 88.33, SD = 13.02$ ). There was no significant correlation ( $r = -.213, p = .112$ ) between the two measures of cognitive flexibility (GoNogo and Stroop test) so both measures were entered separately in correlation analysis. As can be seen in Table 2, there were no significant correlations found between any of the cognitive measures and behaviour questionnaires in the TBI group.

**Table 2.** Correlations between measures of social and cognitive functioning and measures of post-TBI behaviour in the TBI group.

	NBAP (n = 39)	CIQ (n = 39)	NBAP (proxy) (n = 28)	DEX (proxy) (n = 31)
Emotion Recognition Composite Score (n = 38)	-.305 <i>p</i> = .130	.481 <i>p</i> = .013	-.168 <i>p</i> = .413	-.200 <i>p</i> = .328
Theory of Mind Composite Score (n = 37)	-.204 <i>p</i> = .317	.276 <i>p</i> = .172	.085 <i>p</i> = .679	-.126 <i>p</i> = .538
GoNogo Task (n = 28)	-.004 <i>p</i> = .987	.276 <i>p</i> = .253	.009 <i>p</i> = .971	.180 <i>p</i> = .461
Stroop Test (n = 37)	.006 <i>p</i> = .979	-.225 <i>p</i> = .355	-.139 <i>p</i> = .570	.143 <i>p</i> = .561
Trail Making (Processing Speed) (n = 38)	-.363 <i>p</i> = .126	-.505 <i>p</i> = .028	-.136 <i>p</i> = .578	-.258 <i>p</i> = .286
Digit Span Forward (Attention) (n = 37)	.041 <i>p</i> = .866	-.055 <i>p</i> = .825	-.143 <i>p</i> = .560	-.042 <i>p</i> = .864
Digit Span Backward (Working Memory) (n = 37)	.177 <i>p</i> = .468	.049 <i>p</i> = .842	.154 <i>p</i> = .530	-.184 <i>p</i> = .928

Note: \*significant when corrected for multiple comparisons to .002

NBAP: The Neuropsychological Behaviour and Affect Profile; CIQ: Community Integration Questionnaire; NBAP (proxy): The Neuropsychological Behaviour and Affect Profile – Proxy version; DEX (proxy): The Dysexecutive Questionnaire – Proxy version

NBAP self-rated ( $M = 23.33$ ,  $SD = 11.28$ ) and proxy-rated ( $M = 19.93$ ,  $SD = 12.57$ ) measures were significantly correlated ( $n = 28$ ,  $r = .657$ ,  $p < .001$ ). This indicates that both forms of the NBAP are likely to tap into similar socio-emotional behaviours.

#### **3.4.4 Statistical Analyses**

The analysis for hypothesis 1 (MANOVA) shows that the magnitude of the effect is small to medium for all tasks (Cohen, 1992). The analysis for hypothesis 2 (Correlation) also shows that the size of the effect is small to medium for all correlations between cognitive assessments and socio-emotional behaviour questionnaires (Field, 2013). The only exception was a large relationship ( $r = .505$ ) between a task of processing speed (Trail Making Task) and a socio-emotional behaviour questionnaire (CIQ). However, this correlation was non-significant following an adjustment for multiple comparisons. It is likely that this occurred as the Bonferroni is a conservative adjustment.

### **3.5 DISCUSSION**

The aim of this research was to explore whether impairments in emotion recognition, ToM, or cognitive flexibility might be associated with socio-emotional behaviour following TBI. Thus, the study 1) looked at the performance of a TBI group versus a control group on measures of social cognition, and 2) investigated any associations between aspects of social cognition and post-TBI ratings of socio-emotional behaviour. Social cognition was broken down into three categories following Corrigan's Adequate Social Behaviour model. These included: 1) perception of

social cues (emotion recognition); 2) retrieval of social knowledge (theory of mind); and 3) response selection (cognitive flexibility). As there has been previous research into other cognitive aspects and behaviour post TBI, a measure of processing speed, attention and working memory was also included. Due to previous research, it was hypothesised that the TBI group would have significantly poorer performance compared with controls on all cognitive measures. The second aim was mainly explorative; therefore we did not have a directional hypothesis.

### **3.5.1 Between group comparisons**

Analysis included a between subject (TBI and control groups) comparison of means on all measures. Results showed that controls significantly outperformed the TBI group on both emotion recognition measures; suggesting that emotion recognition is impaired in a TBI population, supporting previous research (Hopkins *et al.*, 2002, Milders *et al.*, 2003). The TBI group was also found to perform significantly poorer on three of the theory of mind tasks, again consistent with previous research (Channon & Crawford, 2000; Milders *et al.*, 2003). There was no significant difference between groups on the other ToM test (the Hinting Task), which could be explained by ceiling effects within this task indicating that this test has limited sensitivity heightening the likelihood of Type II errors.

There was no significant difference between groups on the cognitive flexibility tasks, which was unexpected as there is widely supported research showing impairment in cognitive flexibility following brain injury (e.g. Ben-David, Nguyen & van Lieshout, 2011). Impairment in cognitive flexibility has been shown in patients with frontal

lobe damage following TBI (Blumer & Benson, 1975), so it is surprising that there was not a difference detected between groups. A possible explanation could be due to a sampling issue. The site of brain injury was not known so it is possible that the sample did not have a high number of individuals with frontal lobe damage that is usually observed within a TBI population (Blumer & Benson, 1975). However, the TBI group was found to perform worse than controls on a task of processing speed and on a task of working memory, which indicate that the TBI group are especially vulnerable to becoming compromised post-TBI which again supports findings in previous research (MacFlynn, Montgoner, Fenton & Rutherford, 1984; Sohlberg & Mateer, 2001).

### **3.5.2 Relationship between cognition and behaviour**

There were no significant relationships found between social cognition measures and socio-emotional behaviour following TBI, which is unlikely to be due to poor validity of the questionnaires used. All the behaviour questionnaires had been previously used within a TBI population and had shown good validity and reliability (Hanks, Temkin, Machamer & Dikmen, 1999; Hart, Whyte, Kim & Vaccaro, 2005; Mathias & Coats, 1999).

The majority of social cognitive measures used here have been used within a TBI population and have shown sensitivity to impairment. The ceiling effect found in the Hinting task could bring into question the sensitivity of that measure. However, there was more than one measure used to assess this area of social cognition (ToM), all of which were highly correlated. It is therefore unlikely that the measures chosen could



account for the lack of association between social cognition and socio-emotional behaviour. However, there are no studies that have specifically assessed the psychometric properties of these measures. Therefore, the actual validity and internal consistency of these measures are unknown. For this reason these measures are not appropriate for diagnostic purposes and they should only be used in experimental research until validated. For this reason, the current results should be interpreted with caution as we cannot be certain that these tests measure the constructs in question. However, due to high correlations within the tests of emotion recognition and within the tests of ToM, it is likely that these measures tap into their respective abilities.

The socio-emotional behaviour ratings are based on self and proxy reports rather than observations by the clinician or researcher. It is possible that the participants may have varying levels of insight impacting on the reliability of the self-rated measures. Research suggests that patients who have suffered a severe TBI, often overestimate their ability to control their emotions and socially interact when compared to ratings by family members (Prigatano, 1996). However, in the current study a significant correlation was found between the self- and proxy-rated NBAP questionnaires indicating that both the TBI participant and their relative gave similar ratings for the individual's socio-emotional behaviour suggestive that the rating is a fair representation of the individual's level of behavioural functioning.

The literature shows conflicting evidence for associations between social cognition and socio-emotional behaviour. In a TBI population, the relationship between

emotion recognition and behaviour has only been looked at in the current study and in the Milders *et al.* (2008) study, both of which suggest that there is no significant correlation. However, a study looking at this relationship within a Schizophrenic population found a significant relationship (Hooker & Park, 2002). Although significant correlations were only found within two out of nine tested domains of socio-emotional functioning.

Previous research is also mixed when looking at the relationship between ToM and socio-emotional behaviour following TBI. Again, Milders *et al.* (2008) also found no evidence of an association, supporting the current findings. However, there are also studies that have found a relationship between the Faux Pas Test and socio-emotional behaviour in a TBI population (Gregory *et al.*, 2002; Milders *et al.*, 2003).

When interpreting the non-significant correlations found between cognitive flexibility and socio-emotional behaviour within the current study, it is important to consider that there was no impairment found within this sample of individuals following TBI. Previous evidence suggests that this is an unusual finding and so this correlation should be interpreted with caution. Past research does show conflicting findings when looking at the relationship between executive functioning and socio-emotional behaviour. There is previous evidence to support the lack of association found within the current paper (e.g. Bogod *et al.*, 2003; Milders *et al.*, 2003, 2008). However, again there are studies that found a significant correlation within a TBI group (e.g. Vilkki *et al.*, 1994; Nybo *et al.*, 2004).

### **3.5.3 Limitations**

1) The database from which participants were drawn did not hold information relating to the area of brain damage. As such factors are known to have an impact on cognitive functioning post-TBI (Lezak, Howieson & Loring, 2004), information relating to this would have been useful in order to evaluate their potential effects on test performance. Information relating to this could have provided an explanation as to why there was no significant difference found between groups on tests of cognitive flexibility.

2) The length of time the battery took to administer may have had an impact on performance. It is well documented that fatigue is a common symptom following TBI (Cantor *et al.*, 2008). Therefore, it is possible that fatigue had an impact on the TBI group's performance on cognitive tasks. An attempt was made to manage this by monitoring fatigue levels through asking the participant if they were tired and offering a break in the middle of testing, but it was rare that participants decided to take the break. The test order was also varied with every participant to try to reduce the impact of fatigue on the same measures administered at the end of the assessment session. Due to the length of testing, there were participants who were unable to complete the full battery of tests. This had an impact on the number of participant results for each test. However, an attempt was made to account for this by randomising the order of the measures. The number of participants that completed each test is reported in Table 1 and 2. Future research may try to reduce the length of the test battery or insist on splitting the testing over two sessions to try to control for

any impact of fatigue. However, attrition rates are likely to increase if participants are required to attend multiple sessions.

3) Socio-emotional behaviour was measured by self- and proxy-rated questionnaires and although the correlation analysis showed a significant relationship between the self- and proxy-ratings on the NBAP, previous research suggests that clinician ratings are more accurate (Norris & Tate, 2000). Therefore, future research may benefit from clinician ratings and observation to ensure more objective ratings of socio-emotional behaviour.

4) A limitation within the current study was the sample size, which was not as large as the power analysis indicated for correlation analysis. Therefore, it is possible that a bigger sample size might have improved the likelihood of finding significant relationships if these exist. This is more likely to affect the association between the Trail Making Task and the CIQ, which had a large effect size ( $r > .50$ ; Cohen, 1992). However, it is unlikely to affect the correlations between the social cognitive measures and the socio-emotional behaviour questionnaires, most of which were comparatively small. In addition, the sample size in the current paper is similar to that of other studies that found significant relationships between social cognition and socio-emotional behaviour (Nybo *et al.*, 2004; Tate, 1999).

#### **3.5.4 Clinical Application**

Following a TBI, the literature highlights the magnitude of impact of socio-emotional behaviour difficulties on quality of life (Dahlberg *et al.*, 2006),

relationships (Parente *et al.*, 1990), vocational outcome (Lezak & O'Brien, 1988) and social integration (Oddy *et al.*, 1985). For this reason, intervention following TBI should address socio-emotional behaviour difficulties. Sign Guidelines (2013) have limited recommendations of intervention for these behavioural difficulties following TBI due to a lack of evidence-base within this field of research. If there was a greater understanding of the underlying cognitive deficits of socio-emotional behaviour, interventions may be more successful if they could address these cognitive impairments. The current study did not suggest that emotion recognition, ToM or cognitive flexibility should be the area of focus for these interventions. However, further research is needed if an effective intervention for socio-emotional behaviour is to be established.

### **3.5.5 Conclusion**

In conclusion, the results from this study suggest that when compared to healthy controls, those that suffer TBI perform more poorly on measures of emotion recognition and ToM. However, the findings from this test group suggest that there was no significant difference in performance on tests of cognitive flexibility. There was no significant association found between any of the measures selected to represent the three stages of social cognition in Corrigan's model and the socio-emotional behaviour ratings in a TBI sample.

Despite the limitations of this study, there is little evidence that Corrigan's Adequate Social Behavioural Model's stages are associated with social behavioural functioning in a TBI population. However, the conflicting findings within previous research

highlight the complexity in measuring social cognition (Crawford & Henry, 2005) and the challenges posed by the heterogeneous neuropsychological profiles within the TBI population. It is also possible that the chosen measures may not have adequately captured the constructs that are proposed to contribute to the model. In further research, it would be prudent to carry out a similar analysis looking at other social cognitive measures that fit under the social constructs of Corrigan's model.

There are only a small number of research papers looking at the association between emotion identification, ToM and socio-emotional behaviour following TBI, and due to conflicted results within these papers there is limited support for the current findings. For future research, it would be useful to look at additional measures of cognitive flexibility, ToM and emotion recognition. It would also be important to look at other aspects of cognition that might underlie social behaviour, for example, self-monitoring, tracking and social cues (such as body language). Other possible areas include self-control, empathy and initiation of action (Milders *et al.*, 2008; Wells, Dywan & Dumas, 2005).

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## 5. Appendices

### 5.1 Appendix 1. NICE Checklist (Appraisal checklist – quantitative studies reporting correlations and associations)

<b>Study identification:</b> Include full citation details	
<b>Study design:</b>  Refer to the glossary of study designs (appendix D) and the algorithm for classifying experimental and observational study designs (appendix E) to best describe the paper's underpinning study design	
<b>Guidance topic:</b>	
<b>Assessed by:</b>	
<b>Section 1: Population</b>	
<b>1.1 Is the source population or source area well described?</b>  Was the country (e.g. developed or non-developed, type of health care system), setting (primary schools, community centres etc), location (urban, rural), population demographics etc adequately described?	++  +  –  NR  NA
<b>1.2 Is the eligible population or area representative of the source population or area?</b>  Was the recruitment of individuals, clusters or areas well defined (e.g. advertisement, birth register)?  Was the eligible population representative of the source? Were important groups underrepresented?	++  +  –  NR  NA
<b>1.3 Do the selected participants or areas represent the eligible population or area?</b>  Was the method of selection of participants from the eligible population well described? What % of selected individuals or clusters agreed to participate? Were there any sources of bias?  Were the inclusion or exclusion criteria explicit and appropriate?	++  +  –  NR  NA
<b>Section 2: Method of selection of exposure (or comparison) group</b>	

<p><b>2.1 Selection of exposure (and comparison) group. How was selection bias minimised?</b></p> <p>How was selection bias minimised?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR</p> <p>NA</p>
<p><b>2.2 Was the selection of explanatory variables based on a sound theoretical basis?</b></p> <p>How sound was the theoretical basis for selecting the explanatory variables?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR</p> <p>NA</p>
<p><b>2.3 Was the contamination acceptably low?</b></p> <p>Did any in the comparison group receive the exposure?</p> <p>If so, was it sufficient to cause important bias?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR</p> <p>NA</p>
<p><b>2.4 How well were likely confounding factors identified and controlled?</b></p> <p>Were there likely to be other confounding factors not considered or appropriately adjusted for?</p> <p>Was this sufficient to cause important bias?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR</p> <p>NA</p>
<p><b>2.5 Is the setting applicable to the UK?</b></p> <p>Did the setting differ significantly from the UK?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>Section 3: Outcomes</b></p>	
<p><b>3.1 Were the outcome measures and procedures reliable?</b></p> <p>Were outcome measures subjective or objective (e.g. biochemically validated nicotine levels ++ vs self-reported smoking –)?</p> <p>How reliable were outcome measures (e.g. inter- or intra-rater reliability scores)?</p> <p>Was there any indication that measures had been validated (e.g. validated against a gold standard measure or assessed for content validity)?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>

<p><b>3.2 Were the outcome measurements complete?</b></p> <p>Were all or most of the study participants who met the defined study outcome definitions likely to have been identified?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>3.3 Were all the important outcomes assessed?</b></p> <p>Were all the important benefits and harms assessed?</p> <p>Was it possible to determine the overall balance of benefits and harms of the intervention versus comparison?</p>	<p>+++</p> <p>–</p> <p>NR, NA</p>
<p><b>3.4 Was there a similar follow-up time in exposure and comparison groups?</b></p> <p>If groups are followed for different lengths of time, then more events are likely to occur in the group followed-up for longer distorting the comparison.</p> <p>Analyses can be adjusted to allow for differences in length of follow-up (e.g. using person-years).</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>3.5 Was follow-up time meaningful?</b></p> <p>Was follow-up long enough to assess long-term benefits and harms?</p> <p>Was it too long, e.g. participants lost to follow-up?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>Section 4: Analyses</b></p>	
<p><b>4.1 Was the study sufficiently powered to detect an intervention effect (if one exists)?</b></p> <p>A power of 0.8 (i.e. it is likely to see an effect of a given size if one exists, 80% of the time) is the conventionally accepted standard.</p> <p>Is a power calculation presented? If not, what is the expected effect size? Is the sample size adequate?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>4.2 Were multiple explanatory variables considered in the analyses?</b></p> <p>Were there sufficient explanatory variables considered in the analysis?</p>	<p>++</p> <p>+</p> <p>–</p> <p>NR, NA</p>
<p><b>4.3 Were the analytical methods appropriate?</b></p> <p>Were important differences in follow-up time and likely confounders adjusted for?</p>	<p>++</p> <p>+</p>

	– NR, NA
<b>4.6 Was the precision of association given or calculable? Is association meaningful?</b>  Were confidence intervals or p values for effect estimates given or possible to calculate?  Were CIs wide or were they sufficiently precise to aid decision-making? If precision is lacking, is this because the study is under-powered?	++  +  –  NR, NA
<b>Section 5: Summary</b>	
<b>5.1 Are the study results internally valid (i.e. unbiased)?</b>  How well did the study minimise sources of bias (i.e. adjusting for potential confounders)?  Were there significant flaws in the study design?	++  +  –
<b>5.2 Are the findings generalisable to the source population (i.e. externally valid)?</b>  Are there sufficient details given about the study to determine if the findings are generalisable to the source population?  Consider: participants, interventions and comparisons, outcomes, resource and policy implications.	++  +  –



## 5.2 Appendix 2: Patient invitation to participate in study



Dr Maggie Whyte, Dr Fiona Summers, Dr Bruce Downey, Dr Jackie Hamilton.

Dept. of Neuropsychology  
Ashgrove House  
Aberdeen Royal Infirmary  
Forresterhill  
Aberdeen  
AB25 2ZN

Tel: 01224

Dear Sir/Madam

We would like to invite you to participate in a new study on the psychological consequences of head injury. I have enclosed an information sheet that will tell you more about the study.

If after reading the information you would like to take part, or if you would like to know more about the study before you decide, please tick the Yes box on the enclosed Reply Form. The Reply Form can be returned to Dr Bruce Downey in the stamped addressed envelope provided. After we receive your Reply Form and you have ticked the Yes box, you will be contacted by the researchers to arrange an appointment.

If you would like further information, please contact the researchers:

Dr Maarten Milders (email: [m.milders@hw.ac.uk](mailto:m.milders@hw.ac.uk))

Michelle May (email: [michelle.may@nhs.net](mailto:michelle.may@nhs.net)).

Thank you for your interest in our study,

Dr Maggie Whyte, Dr Fiona Summers, Dr Bruce Downey, Dr Jackie Hamilton.

### **5.3 Appendix 3: Participant reply form**

#### **REPLY FORM**

##### **Psychological consequences of head injury**

☐

YES – I would like to consider participating in this study and would like to arrange an appointment for further information.

☐

NO – I am not interested in participating in this study.

Please enter your name, address and telephone number and return this form to Dr Bruce Downey in the stamped addressed envelope provided.

Your Name

.....

Your Address

.....

.....

.....

.....

Your Telephone number: .....

.....

## **5.4 Appendix 4: Information sheet for participants**

### **Invitation**

This sheet contains information about a study on the psychological consequences of head injury. We would like to invite you to participate in this study, but we understand that you would like to know more about the study before you decide.

Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part. Thank you for reading this.

### **What is the purpose of the study?**

Many people experience difficulties when trying to return to work or a 'normal' social life after a head injury. The aim of this study is to learn more about the possible causes of these difficulties and how such difficulties may be prevented in the future.

### **Why have I been chosen?**

People who have suffered a head injury whether recently or in the past and who have been seen by a neuropsychologist at Ward 40, Aberdeen Royal Infirmary, are being invited to take part in the study. We will invite about 40 people with head injury to participate in this study.

### **Do I have to take part?**

No. Taking part in this study is completely voluntary. When you agree to take part, you can still withdraw at any time and without having to give a reason for your

decision. If you do not want to take part or if you decide to withdraw later on, this will have no effect on the standard of care that you receive.

If you would like to take part in the study, or if you would like to know more about the study before you decide, please tick the Yes box on the enclosed Reply Form. If you are not interested to take part, please tick the No box.

### **What will happen to me if I take part?**

If you have ticked the Yes box on the Reply Form, you will be contacted by Michelle May to arrange an appointment. The study will take place at the School of Psychology of the University of Aberdeen. At the arranged appointment Michelle will give you further details of the study and you can ask questions that you may have. If at this point you decide you do not want to participate, you can of course withdraw.

If you agree to take part in the study, you will be asked to complete a number of short tests and questionnaires. The tests involve various tasks, such as recognising pictures of facial expressions or judging social situations from a series of short stories. Some of the tests will be presented on a computer and will require you to press keys on the keyboard. The whole assessment will take approximately two hours. If this is too long for you, testing can be done in two or more shorter sessions. If you agree to participate, we will also ask a relative or carer of yours to complete a questionnaire concerning your recovery and activities.

### **Are there any lifestyle restrictions?**

No, there are no lifestyle or dietary restrictions and you should continue to take any regular medication.

### **What are the possible benefits of taking part?**

There is no immediate clinical benefit to you from taking part in the study. However, your participation would advance research which may help us to better understand and help others in the future.

**What if something goes wrong?**

*If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal University of Aberdeen complaints mechanisms should be available to you.*

**Will my taking part in this study be kept confidential?**

You will be asked for permission to allow the information collected about you in the course of the study to be recorded and stored. All the information that is collected about you during the study will be strictly confidential and anonymous, so it will be impossible to identify you from the information collected.

**What will happen to the results of the research study?**

You will be able to find out the results of the study in the autumn of 2011. The results of the study will be written up as part of a thesis project at the University of Edinburgh and will be put forward for publication in a reputable scientific journal at a later stage.

**Who has reviewed the study?**

*The research is being carried out in collaboration with NHS Grampian. The study has been reviewed and approved by the North of Scotland Research Ethics Committee.*

## **Contact for Further Information**

When you have decided that you would like to take part in the study, or that you would like to know more about the study before you decide, please tick the Yes box on the enclosed Reply Form. When you have decided that you do not want to take part please tick the No box. Please also put your name, address and a contact telephone number on the Reply Form. You can return the completed Reply Form in the stamped addressed envelope provided to Dr Bruce Downey at Aberdeen Royal Infirmary. We will contact you when we have received your Reply Form but only if you have ticked the Yes box. We will not make any further contact with you if you tick the No box and if you do not return the reply form we will not contact you.

If you have any further queries concerning this study, do not hesitate to contact either Dr Maarten Milders (email: [m.milders@hw.ac.uk](mailto:m.milders@hw.ac.uk)) or Michelle May (email: [michelle.may@nhs.net](mailto:michelle.may@nhs.net)).

Thank you for considering taking part in this study.

Dr. Maarten Milders

Michelle May

## **5.5 Appendix 5: Participant Consent form**

**Title of Project: The Psychological consequences of head injury.**

Names of Researchers:        Dr Maarten Milders  
   Michelle May

**Please initial box**

- 1        I confirm that I have read and understand the information sheet ☐  
          dated ..... for the above study. I have had the opportunity to  
          consider the information, ask questions and have had these  
          answered satisfactorily.
- 2        I understand that my participation is voluntary and that I am free to ☐  
          withdraw at any time, without giving any reason, without my  
          medical care or legal rights being affected.
- 3        I agree to my data being collected, recorded and stored ☐  
          electronically during this  
          study.
- 4        I agree to take part in the study of the psychological consequences ☐  
          of head injury.

Your Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## 5.6 Appendix 6: Ethical Approval

### NRES Committees - North of Scotland

Summerfield House  
2 Eday Road  
Aberdeen  
AB15 6RE

Telephone: 01224 558458  
Facsimile: 01224 558609  
Email: nosres@nhs.net



20 December 2012

Dr Maarten Milders  
Lecturer  
Heriot-Watt University  
School of Life Sciences  
Heriot-Watt University  
EDINBURGH  
EH14 4AS

Dear Dr Milders

**Study title:** Neuropsychological deficits underlying changes in social and emotional behaviour following Traumatic Brain Injury (TBI) in patients.  
**REC reference:** 09/S0802/27  
**Protocol number:** pRGF/021/009  
**Amendment number:** AM04 (AM07 for REC Reference Only)  
**Amendment date:** 17 December 2012  
**IRAS project ID:** 17066

The above amendment was reviewed by the Sub-Committee in correspondence.

### Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

### Approved documents

The documents reviewed and approved at the meeting were:

Document	Version	Date
Letter from Sponsor		17 December 2012
Letter of invitation to participant	5	17 December 2012
Participant Consent Form	5	17 December 2012
Participant Information Sheet: Relatives - Controls	5	17 December 2012
Participant Information Sheet	6	17 December 2012
Participant Information Sheet: Relatives - Patients	5	17 December 2012
Participant Information Sheet: Controls	6	17 December 2012



Document	Version	Date
Notice of Substantial Amendment (non-CTIMPs)	AM04 (AM07 for REC Reference Only)	17 December 2012
Covering Letter	Email	18 December 2012

#### Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

#### R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

#### Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

<b>09/S0802/27: Please quote this number on all correspondence</b>
--

Yours sincerely

*Craig Irvine*

Dr Alex Johnstone  
Chair

Enclosures: List of names and professions of members who took part in the review

Copy to: Dr A G Weir, Heriot-Watt University  
NHSG R&D Department

**NRES Committees - North of Scotland (2)**

**Attendance at Sub-Committee of the REC meeting by correspondence**

<i>Name</i>	<i>Profession</i>	<i>Capacity</i>
Dr Stuart Hannabuss	Lay Member - Independent Researcher	Lay
Dr Alex Johnstone	Chair & Senior Scientist in Human Nutrition	Expert

## **5.7 Appendix 7. Author Guidelines: Neuropsychological Rehabilitation. An International Journal**

### **Author guidelines: manuscript preparation**

#### **1. Journal-specific guidelines**

- This journal accepts original (regular) articles, scholarly reviews, and book reviews.
- The style and format of the typescripts should conform to the specifications given in the Publication Manual of the American Psychological Association (6th ed.).
- There is no word limit for manuscripts submitted to this journal. Authors should include a word count with their manuscript.

#### **2. General guidelines**

- Manuscripts are accepted in English. Oxford English Dictionary spelling and punctuation are preferred. Please use double quotation marks, except where “a quotation is ‘within’ a quotation”. Long quotations of words or more should be indented without quotation marks.
- Manuscripts should be compiled in the following order: title page; abstract; keywords; main text; acknowledgements; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figure caption(s) (as a list).
- Abstracts of 150-200 words are required for all manuscripts submitted.
- Each manuscript should have up to 5 keywords .
- Search engine optimization (SEO) is a means of making your article more visible to anyone who might be looking for it. Please consult our guidance here .
- Section headings should be concise.
- All authors of a manuscript should include their full names, affiliations, postal addresses, telephone numbers and email addresses on the cover page of the manuscript. One author should be identified as the corresponding author. Please give the affiliation where the research was conducted. If any of the named co-authors moves affiliation during the peer review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after the manuscript is accepted. Please note that the email address of the corresponding author will normally be displayed in the article PDF (depending on the journal style) and the online article.
- All persons who have a reasonable claim to authorship must be named in the manuscript as co-authors; the corresponding author must be authorized by all co-authors to act as an agent on their behalf in all matters pertaining to publication of the manuscript, and the order of names should be agreed by all authors.
- Biographical notes on contributors are not required for this journal.

- Please supply all details required by any funding and grant-awarding bodies as an Acknowledgement on the title page of the manuscript, in a separate paragraph, as follows:
  - *For single agency grants:* "This work was supported by the [Funding Agency] under Grant [number xxxx]."
  - *For multiple agency grants:* "This work was supported by the [Funding Agency 1] under Grant [number xxxx]; [Funding Agency 2] under Grant [number xxxx]; and [Funding Agency 3] under Grant [number xxxx]."
- Authors must also incorporate a Disclosure Statement which will acknowledge any financial interest or benefit they have arising from the direct applications of their research.
- For all manuscripts non-discriminatory language is mandatory. Sexist or racist terms must not be used.
- Authors must adhere to SI units . Units are not italicised.
- When using a word which is or is asserted to be a proprietary term or trade mark, authors must use the symbol ® or TM.

## 2. Style guidelines

- Description of the Journal's reference style.
- Guide to using mathematical scripts and equations.
- Word templates are available for this journal. If you are not able to use the template via the links or if you have any other template queries, please contact [authortemplate@tandf.co.uk](mailto:authortemplate@tandf.co.uk).
- Authors must not embed equations or image files within their manuscript

## 3. Figures

- Please provide the highest quality figure format possible. Please be sure that all imported scanned material is scanned at the appropriate resolution: 1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour.
- Figures must be saved separate to text. Please do not embed figures in the manuscript file.
- Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC).
- All figures must be numbered in the order in which they appear in the manuscript (e.g. Figure 1, Figure 2). In multi-part figures, each part should be labelled (e.g. Figure 1(a), Figure 1(b)).
- Figure captions must be saved separately, as part of the file containing the complete text of the manuscript, and numbered correspondingly.
- The filename for a graphic should be descriptive of the graphic, e.g. Figure1, Figure2a.

#### **4. Publication charges**

##### **Submission fee**

- There is no submission fee for *Neuropsychological Rehabilitation* .

##### **Page charges**

- There are no page charges for *Neuropsychological Rehabilitation* .

##### **Colour charges**

- Colour figures will be reproduced in colour in the online edition of the journal free of charge. If it is necessary for the figures to be reproduced in colour in the print version, a charge will apply. Charges for colour figures in print are £250 per figure (\$395 US Dollars; \$385 Australian Dollars; 315 Euros). For more than 4 colour figures, figures 5 and above will be charged at £50 per figure (\$80 US Dollars; \$75 Australian Dollars; 63 Euros).
- Depending on your location, these charges may be subject to Value Added Tax .

#### **5. Reproduction of copyright material**

- If you wish to include any material in your manuscript in which you do not hold copyright, you must obtain written permission from the copyright owner, prior to submission. Such material may be in the form of text, data, table, illustration, photograph, line drawing, audio clip, video clip, film still, and screenshot, and any supplemental material you propose to include. This applies to direct (verbatim or facsimile) reproduction as well as “derivative reproduction” (where you have created a new figure or table which derives substantially from a copyrighted source).
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- The reproduction of short extracts of text, excluding poetry and song lyrics, for the purposes of criticism may be possible without formal permission on the basis that the quotation is reproduced accurately and full attribution is given.
- For further information and FAQs on the reproduction of copyright material, please consult our Guide .

#### **6. Supplemental online material**

- Authors are encouraged to submit animations, movie files, sound files or any additional information for online publication.